EXPERIMENTS

IN

Elementary Agriculture

A Laboratory Manual for the Public Schools

BY

WILLIAM HAROLD DAVIS
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PREFACE

This book is not intended to impart information as a text, but lead others to discover facts for themselves which is the fundamental purpose of a laboratory manual.

In compiling these experiments in Elementary Agriculture, the purpose has been to develop a practical and pedagogical method and at the same time present suitable material for the work in the common schools. The teacher is directed to give instruction in live things and not depend upon the subject matter of text books. By this method, both teacher and pupils will feel a genuine interest in nature and a growth in both intelligence and observation will result. Pupils are always interested in experimentation because it appeals to the practical side of judgment and is full of interest and novelty. They enjoy reality because they can understand and they decline to appreciate theory with abstract statements because it is not adapted to their comprehension. Knowledge first hand, such as is obtained from nature, is always to be preferred to second hand knowledge, such as is furnished by text books, and the teacher should always seek the way that makes the strongest impression when giving effective instruction.

This Manual has abundant references to the latest and best sources of information. Good results are always obtainable by so dividing the work of the students that there will be four laboratory periods a week and three recitation periods, which should consist of assigned class work, reports on experiments or special reading of bulletins by the student talks by the teacher on subjects and phases of the work that are assigned or applied; also, field work, when observation and investigation need to accompany this instruction. Study the subject by topics. The special publication of bulletins mentioned are obtainable from the Department of Agriculture, Washington, D. C. and from the Iowa State College of Ag., Ames, Iowa, on application, as they are mostly distributed free to teachers.

It was not the intention of the author, when he arranged these typical experiments to put them in printed form but so many of his students have solicited copies for their own use and that of associate teachers that he yields to their request and publishes this preliminary edition with the intention of preparing a more complete edition in the near future.

WILLIAM HAROLD DAVIS.
Cedar Falls, Iowa, 1915.

GENERAL DIRECTIONS.

The student must study the question or object of each experiment to understand thoroly the purpose for which he is working. Follow the directions given under *operation* and find your answer, which is the *conclusion*. Note the three steps: question or object, work or operation, answer or conclusion. Copy the question as stated in your directions when you record your work; use the title "Obj."; likewise "Oper." in which you tell just what you did and what you saw in logical sequence, using the first person singular or plural, "I did this" and "I saw", or "we did" and "we saw", etc. Record all measurements in tabulated form; answer all questions; label all drawings; do not copy the operation as given in the directions but describe *your* work and results. The Conclusion should answer the question or Obj. in a clear and concise statement.

A student should not perform every experiment but those best adapted to the course.

EXPERIMENT 1.

Obj. Are the leaves of plants all alike or are there variations?

Refer. Cornell Read. Cour. for Farmers, No. 41, Nov. 1908; Cornell Ag. Exp. Sta. Rept. 1910, p. 421; 1909, pp. 543-558. Far. Bul. 297-313.

Oper.

1. Dig up a healthy ragweed; you may use a bean, dandelion, corn, timothy leaves or heads.
2. Try to find two leaves alike.
3. Draw outlines of as many different shaped leaves as possible.
4. Describe as many differences as you can find. Be brief. Size, shape, color, veining, hairiness, shape of margins; length, size and color of petiole.
5. Does it make any difference from what plants seeds are taken? Explain. Illustrate this by using timothy, clover and corn as an example.

EXPERIMENT 2.

Obj. What are the parts of a flower and the use of each?

Oper. Use any perfect flower—tulip, petunia, lily, morning-glory, etc. If in season use the apple blossom.

2. The green leaf-like structures at the base of the flower are the sepals. The petals comprise the colored portion. Draw and label.
3. In the center is the pistil and around it, next to the petals, are the stamens.
4. The knobbed cup or sticky surface at the top of the pistil is the stigma. Can you find any yellow dust-like material thereon? What is it?
5. At the base of the pistil is a bulb-like structure, the ovary. The style connects the ovary and stigma. Draw and label a pistil.
6. The stamen has a sack-like portion on top, the anther. Open one that is ripe. What is on the inside? Use? The thread-like part leading up to the anther is the filament. Draw and label.
7. With a safety razor blade, cut thin cross sections of an ovary and place under a hand magnifier. Note the wall, the number of chambers or locules, the seed-like structure or ovules, and the material to which attached, placenta. Draw and label.
8. Read in some Botany text pollination and fertilization. Give a separate written description of these two processes with differences. Do not copy the words of the text. Use a drawing.
9. Describe the part each of the following takes in pollination: humming bird, horses, cows, man, wind, ant, etc. Why should a farmer keep honey bees? What agricultural plants need help in pollination? What precautions are sometimes taken to prevent corn from self-pollination?

EXPERIMENT 3.

Obj. Has a corn plant floral part? If so, what are they? Describe each.

Oper. Refer.: Corn Plants, Their Uses and Ways of Life, Sargent, pub. by Houghton, Miff. & Co., N. Y. Also Corn, by Bowman & Crossley, pub. by authors, Ames.

1. Draw a stalk before ripening, label tassel, ear, leaves, stalk, silk, husk, node, internode, ear, leaf sheath and brace root.
2. Draw a section of the tassel showing the stamens with anthers and filaments. There are two bulbs, lodicules, which pry the bracts apart so that the stamens can come out.
4. Draw a young ear showing pistil, ovary, style, stigma with stigmatic hairs, and kernels with silk attached, involucre or husk.

EXPERIMENT 4.

Obj. What is a plant cell? What are its parts?

Oper.

1. Place a leaf of Elodea under the microscope. You may also use the epidermis stripped from one of the following leaves: beet, canna, tradescantia, lily, or leaf of any water plant.
2. Make out the wall; protoplasm—small granules or minute particles looking like dirt; chloroplastid—a green body which manufactures the food; food particles—a part of the protoplasm, starch, etc. The vacuole occupies the central portion and is mostly filled with water. The nucleus may not be visible but a spherical mass of protoplasm suspended near the center of the cytoplasm.
3. Draw a cell at least one inch in diameter, showing the parts observed.
4. You may use a prepared slide or stained specimen for observing protoplasm, nucleus, nucleolus, protoplasmic membrane, vacuole starch and other food particles.

EXPERIMENT 5.

Obj. How may I distinguish the fourteen noxious weeds of Iowa? Also other prevalent ones?

Oper. Refer.: Gray's New Manual of Botany; Iowa Geol. Survey—Bul. 4 by Pammel, p. 796.

Bulletins: Weed Laws of Ia. Circ. 5, Ames; Iowa Yr. Bk., V. 13, p. 542; Eradication, Ia., 105; Mich. 260; Farm. Bul., 124; 215; 28; 10; 94; 194; 10; 188; 186.

1. Read one of the previous bulletins assigned; write a review. do not copy the bulletin. Report to class without notes.
2. Collect specimens of the weeds studied in the field; label, take to the laboratory, press; mount with passe-partout and name in your note book. Hand in for credit.

3. List of the fourteen unlawful weeds of Iowa.

1. Quack grass—Agropyron repens.
2. Canada thistle—Cirsum arvense.
3. Cocklebur—Xanthium canadense.
4. Wild mustard—Brassica arvensis.
5. Curled dock—Rumex crispus.
6. Smooth dock—Rumex altissimus.
7. Buckhorn—Plantago lanceolata.
8. Wild parsnips—Pastinaca sativa.
9. Horse nettle—Solanum carolinense.
10. Velvet weed—Abutilon Theophrasti.
11. Burdock—Arctium Minus.
12. Shoo-fly—Hibiscus trionum.
13. Wild carrot—Daucus carota.
14. Russian thistle—Salsola kalivar tenuifolia.

Outline for the study of weeds.

1. Ident. of 15 common—
2. Methods of spreading.
3. Roots and classification

Annual
Perennial
Biennial

4. Weed control and erad.—5 methods.
5. Weed laws of the 14 unlawful weeds of Iowa.
6. Damages and benefits.
7. Definition.
8. Weed seeds.

EXPERIMENT 6.

Obj. How do the number of seeds on a weed compare with those on a cultivated plant?
Seeds of Michigan Weeds. 260.

Oper.

1. Collect a whole weed with seeds as lamb's quarters, fox tail, dandelion, smartweed, ragweed or prickly amaranth.
2. Count the seeds on an *average sized* stalk or head and multiply this by the number of such stalks or heads on the plant. This will give the approximate number of seeds. You may count the seeds.
3. Count the kernels in one row of corn-on-the-cob, then estimate the number of kernels on the plant.
4. Compare the weed seeds with the kernels.
5. Estimate the number of plants that might spring from one weed in five years. The same from corn. Compare.

EXPERIMENT 7.

(By E. L. Palmer.)

Obj. To distinguish between the seeds of some of the common clovers and grasses.

Mater. Magnifying glass. Seeds of Alsike Clover, White Clover, Red Clover and Alfalfa; also Timothy, Orchard and Kentucky Blue Grass.

Oper. Part 1. The Clovers.

Describe the seeds according to the following chart:

Length, width, smoothness, position of the notch on end or side, angular or regularly rounded, color, lustre; sketch the outline 1 in. in diam.

	Alfalfa	Red Clover	White Clover	Alsike Clover
Length				
Width				
Smoothness				
Position of Notch on end or side				
Angular or regularly rounded				
Color				
Lustre				
Outline sketch 1 inch in diameter				

Part II.—The grasses.

Describe the seeds according to the following chart.

Length, width, color of (a) seed; (b) scale, with or without a fine tipped scale, number of scales. Sketch 2 in. in length.

NOTE—Length and width of seeds are expressed so as to show the greatest and least measurements, as 2-4 m. m.

	KENTUCKY BLUE GRASS	ORCHARD	TIMOTHY
Length			
Width			
Color of— (a) Seed			
(b) Scale			
With or without spine-tipped scale			
Number of Scales			
Sketch (2 inches in length)			

Summary:

What differences do you notice between grass and flower seeds?

Which would be more liable to harbor spores of fungous diseases and why?

Which would be more easily adulterated?

Mix five seeds of each of the above kinds and then separate them correctly.

Reference:

F. B. Testing farm seeds in home and in the Rural Schools, by F. H. Hillman.

Lustre—expressed in terms such as shining, dull, granular, oily, with a sheen, etc

EXPERIMENT 8.

(By E. L. Palmer.)

Obj. To be able to identify the seeds of some of the more pernicious weeds found in commercial seeds.

Mater. Seedss Quack grass, Agropyron repens; Canada Thistle, Cirsium arvense; Wild Mustard, Brassica arvensis; Curled Dock, Rumex crispus; Buckhorn, Plantago lanceolata.

NOTE—The other noxious weeds of Iowa, while they are bad, are not as a rule distributed by being found in commercial seeds or closely resemble some of the seeds included in the above list. The seeds of the above plants should be collected in the Fall. Classify according to the following chart:

Length, width, color, lustre, surface, shape in cross section, number of scales present, sketch the outline 1 in. in length.

	Dock	O Grass	W. Mustard	Buchorn	C. Thistle
Length					
Width					
Color					
Lustre					
Surface					
Shape in cross-section sketch					
Number of scales present					
Make an outline sketch 1 inch in length					

Summary:

Which of these more closely resemble clover seeds in shape and size? Which grass seeds? Mix some of these seeds with the seeds they most closely resemble and then separate them correctly.

The teacher should prepare seeds and adulterants and have the pupils determine the adulterants present.

Reference:

F. B. 428, Seed Testing in Rural School.

F. B. 382, Adulteration of Forage Plant Seeds.

Mich. 260, Seeds of Michigan Weeds, E. Lansing, Mich.

EXPERIMENT 9.

(By E. L. Palmer.)

Obj. To determine the percentage purity of certain commercial seeds.

Mater. Samples of seeds prepared by the teacher where the purity is known. Samples secured from home or elsewhere, where purity is unknown. Samples taken from seeds at home should be selected from various parts of the bag—top, bottom, sides and centre. They should be mixed and sub-divided so that the final sample will be fairly representative of the quality of the whole sack.

Method:

1. Weigh the sample very carefully on a postal scale or some even more delicate balance.
2. Separate all foreign matter—sand, broken and foreign seeds.
3. Weigh this foreign matter and compute the percentage purity of the whole sample.
4. After determining the percentage which will germinate, determine the actual price of good seed in the sample.

EXPERIMENT 10.

Obj. What per cent of the alfalfa, clover and timothy seed given me will germinate? How long does it take each to sprout?

Oper. Reference, Far. Bul. 408 and 194.

1. Soak filter paper, colorless blotting paper, papers, tissue paper or cloth in warm water.
2. Remove, spread out flat in a porcelain basin or plate.
3. Count out a certain number of seeds, as twenty of each (the more the better is your test). Label on the paper. Cover with damp paper then loosely with dry paper so they will not dry. Set in warm place until they sprout.
4. Make a table showing dates, which sprouted first, the number and the temperature.
5. The seeds may be sown on soaked cotton floating in a tumbler of water. They will germinate quicker if, before sowing, they are soaked over night in running water.
6. Seeds may be sown on damp linen spread over dampened sawdust or sand. Then it is best to cover with linen on top on which is more damp saw dust, etc.
7. If you wanted 15 alfalfa plants per sq. ft., how many seeds would you sow per A.? How many pounds? (Weigh by your own method and find out.)

EXPERIMENT 11.

Obj. How may I distinguish alfalfa plants from clover?

Oper. Ref.: Ele. of Ag., Warren, p. 408-410; 188, 284, 287, 405, 410; Far. Bul. 339, 312; Alfalfa, Coburn.

1. Use any kind of clover; red, alsike, or white, etc. Obtain the whole plant.
2. Obtain the whole alfalfa plant, with roots and blossoms, etc.
3. Compare the whole root systems, as to size, shape, length, etc.
4. Compare the stem or stems springing from one root. Try to find how new stems are formed when the old ones are cut. Alfalfa should be cut when these new stems begin to form around the old ones, and the machine should not cut the newer sprouts.
5. Compare the leaves—(the leaf is composed of three leaflets, a divided leaf—as to size, shape, colors, spots, divisions, hairiness, etc.
6. Compare the flowers; put them under a hand lens and note their resemblance to a sweet pea.
7. Compare their food values and nutritive ratios as in Ele. Ag., Warren, Table 8.
8. Make a drawing of root, stem and leaf of each.

EXPERIMENT 12.

Obj. Upon what part of a plant do Nodules appear? Size? Shape? Structure? Number? Use?

Oper. Col. Bot., Atkinson, p. 92; Bact. in Relation to Country Life, Lipman.

1. Use plants in the previous experiments or dig up a fresh plant from the following legumes: Clover, Alfalfa, Peas, Beans.
2. Carefully remove the soil and note the small, roundish knot-like formations on the roots.
3. Find as many sizes as you can; measure, record.
4. Find as many shapes as you can; draw (x4), label, nodules, root, etc.
5. Cut a big nodule open, describe the material. Note—If it is hollow, it is a gall produced by an insect, nematode.

Note.—If the microscope magnifies 800 times or more, you can scrape some of the interior, mount and see the Pseudomonas radicocola. It is better distinguished by aid of stains, etc. It is generally thot that these bacteria take their food from the plant and in turn supply the plant with nitrogen from the air or from the decay of their dead bodies.

EXPERIMENT 13.

Obj. Soil Inoculation.

Oper. Write a composition using this outline:

Intro.:

1. When discovered, by whom and where.

Discuss:

2. What soil inoculation is and how accomplished.
3. Part of the plant affected and how affected.
4. Describe the nodules, size, shape, position and number.
5. What produces nodules and how they enter the plant.
6. Benefits to the plant, soil and man.
7. List of plants grown in Iowa that may be inoculated.
8. How to obtain the inoculating materials.
    a. Market address.
    b. Home preparation.
    c. Soil method.

Con.:

9. Its importance commercially and agriculturally.
10. Your personal opinion of its benefits.

References:

Bureau of Pl. Ind., 71, 1905.
Far. Bul. 214, 124, 240.
Bacteria in Relation to Country Life, Lipman Jr., 221.
Yr. Bk. U. S. Dept. Ag., 1899, p. 248 ("Alinit" Etc. Hist,)
The Soil King, p. 126 (Hellriegel's Work).
Soils, Burkett, p. 145.
Yr. Bk. of U. S. Dept. Ag., 1910, 1902, 322, 1906, 1895, 1897.
Ohio, 244, 630 (Sweet Clover Forerunner of Alfalfa etc.).

Read directions from a package of inoculating material, in laboratory, sent out by each company.

Companies manufacturing inoculating materials.

1. U. S. Dept. Pl. Industry, Washington, D. C.
2. "Farmogen", Earp, Thomas Co., Bloomfield, N. J.
3. "Nitrogen," the German-American "Nitragin" Co., Milwaukee, Wis., but now marketed by Galloway & Co., Waterloo, Ia.
4. Ferguson Nitrogen Bacteria, Homeward Nitragen Co., 55 Liberty St., N. Y.
5. "Legumogerm", Western Legumogerm Co., Topeka, Kan.

EXPERIMENT 14.

Obj. What is fruit? Seed? What are the parts of a bean? Describe each.

Oper. Use dry beans in pod; green "string beans" or canned "string beans". Peas will answer for pod study only.

Pod:

1. To what are the pods fastened? By what? This is the peduncle; find little leaf-like structures where the peduncle

joins the pod. How many? What are these? What part of the flower was the pod, originally? If a flower is at hand, examine. Note the "string" on the pod. What part of the flower was this? What part was fastened to the "string" but is missing now? The matured ovary with its contents and adjoining parts is fruit. Classify the following as fruits or vegetables: peanut, potatoes, peppers, podding pea, orange, lettuce, radish, kernel of corn, tomatoes, turnip, burdock burr, oats.

Seed:

1. To what are beans fastened? By what? This tube-like structure is the funiculus and carries food to the bean. Can you tell where the funiculus joined the bean? How? Describe this scar or hilum.
2. Near one end of the hilum is a small opening thru which air and moisture enter. This is the micropyle.
3. Near the hilum, on the end, opposite the micropyle is a white bead-like structure, the raphe or "flower scar".
4. Note that the bean is covered by tissue, the testa; remove some, hold it between your eyes and light. Describe the quality of the testa that you notice.
5. Draw to show all parts named. NOTE—Make all drawings at least one inch in diameter.
6. Draw three views, to show the different shapes of a bean.
7. Describe each one of the external parts.

Internal: Use soaked beans unless fresh ones are at hand. The anterior or front of the bean is the portion lying near the pod at the hilum.

1. Cut the testa between the halves, at the dorsum or back, open carefully and notice the little plantlet between these cotyledons and how it is attached to each cotyledon. Note the two leaflets or plumule; the stem or hypocotyl. These three parts compose the embryo. Make a drawing of the embryo. The root cannot be distinguished easily.
2. Describe the embryo, testa, hilum and micropyle, giving a use for each.
3. In water, mount thin sections from a part of the cotyledon and place under the microscope. Note the cell walls and starch grains. Draw and label.

NOTE—Germinate seeds and compare with the pea.

EXPERIMENT 15.

Obj. What are the parts of a kernel of corn?

Oper. Reference: Corn Plants, Their Uses and Ways of Life, Sargent; Corn, Bowman and Crossley, p. 345-360; Far. Bul. 298, p. 8-10; 112, p. 14-15; 50, p. 14-16; 293, p. 16.

External: Use a broken cob with yellow corn.

1. How many rows? Is there ever an odd number? How are the rows arranged with reference to each other? Note the pairs. Draw to show this. Also the relation of the kernel.
2. Note the embryo or germ. Does it face the butt or the tip of the ear? Why?
3. Above the embryo, the silk scar.
4. The covering or exocarp; remove some.
5. The areas of a kernel are, crown, center and tip. The crown being from the embryo up; the tip is the part that fits into the cob.
6. Some chaff may be found over the tip.
7. Note the pith, wood portion, cell, etc., of cob.
8. Make a drawing showing above facts.

Internal:

9. Use six soaked kernels of yellow corn. Place a kernel point toward you, embryo up, make a vertical cut from tip to crown thru the center of the embryo.
10. Note the little root or radicle, in a root sheath within the tip of the kernel; the young stem or plumule; the gummy cotyledon. These three comprise the embryo. Take the embryo out of another kernel. Draw and label.
11. Note the yellow, oily endosperm and the white, starchy endosperm of the crown.
12. Remove some of the covering to the kernel, the exocarp.
13. Draw to show the points in 11 and 12; for further study, see reference, especially Far. Bul. 298, p. 9, for the composition of each part. Copy the "Table 1" in your Experiment after the Con.

EXPERIMENT 16.

Obj. What is a good method for testing the presence of protein, albumin or nitrogenous materials in seeds?

Oper. Reference: Exp. With Plants, Osterhout, p. 165.

1. Lay three soaked kernels of corn on their flat face, germs up, crown from you; cut one thru the center, lengthwise, with a horizontal cut.
2. Cut another thru the center, lengthwise, with a horizontal cut.
3. Cut the third crosswise, with a vertical cut thru the center.
4. Spread apart the cotyledons of a soaked bean, cut one into two halves, crosswise.

   Caution—This acid is poisonous, exceedingly injurious to clothing, flesh, iron and tinware. In case of accident, use water freely, then wash in lime water, soda water or in soap. Place refuse in crocks or glassware, bury in the ground; never throw into sinks.
5. Cover the specimens with nitric acid, let stand for five minutes, pour off the acid, save, rinse specimens with water, dampen with ammonia.

6. An orange color shows protein.
7. Sketch each seed showing where the protein is located.

NOTE.—Millon's reagent, or Mercurous Nitrate may be used. See Micro-technique, Zimmerman, p. 129.

EXPERIMENT 17.

Obj. What is a good method for detecting the presence of starch in any seed?

Oper. Cut several corn kernels thru different parts, place these in a dish or on a paper. Paint over with iodine (the tincture may be purchased at a drug store.) What change takes place?

2. In what part is the most starch located?
3. What parts contain little starch?

NOTE.—You may boil some endosperm in a test tube one-third filled with water, cool, then insert the iodine or, boil the bisected seeds, and add iodine; test a slice of potato and cotyledon of a bean. Dig a small hole in the material and pour a little iodine therein.

EXPERIMENT 18.

Obj. How is the starch stored in corn and beans? Like what do starch grains appear. Describe.

References Far. Bul. 249, p. 11; 295, p. 14; 298, p. 8.

Oper. With a safety razor cut a very thin slice of the material, using soaked seeds, the endosperm of corn and the cotyledon of a bean.

2. Mount this material in water, place under the high power of a microscope. Draw. Label cell wall, starch grain, etc.
3. Run iodine under the cover glass. Describe, giving reason for the change.
4. Compare the starch grains of each. How may they be told apart?

EXPERIMENT 19.

Obj. How may I extract oil from seeds?

Oper. Use seeds from flax, cotton, corn, or use one of the following meals: oil, cotton seed, corn.

1. Grind or crush the seeds.
2. Mix thoroly with ether or benzine and let stand for 10 or 15 minutes.
3. Either pour this mixture on white paper, let dry, and note the surface; or,
4. Filter, allow the ether of the filtrate to evaporate and describe the residue.
5. Test this: Which contains the more oil, the embryos from twenty corn kernels or the endosperms?

EXPERIMENT 20.

Obj. What are the parts of a potato? Give a use for each.

Oper. Reference: Far. Bul. 295, p. 9. The Potato, Grubb & Guilford, Doubleday, Page & Co.

It is better to use a whole plant, if possible.

1. The potato is covered with a "skin," "jacket" or epidermis. Remove some. Describe its color, thickness, etc. It is an underground stem or tuber. To what part of a tree's stem does its epidermis correspond? Use?
2. Find a small piece of stem which connected it with the other plant part.
3. Opposite this, find the terminal or end bud.
4. Examine a well developed bud; note the color of tip, base, etc.
5. Note the "eye" which consists of the bud and a crescent, shield-shaped projection or *leaf*. Draw an eye x4; label.
6. Do the "eyes" or buds have a mathematical arrangement? Make out a spiral arrangement. (Phyllotaxy, two-fifths.)
7. Draw a tuber, life size, bringing out the above facts.
8. Draw to show three shapes of a tuber with major axis, minor axis, thickness.
9. To see the buds develop, place a potato in the neck of a bottle filled with water and let stand under proper conditions for growth.

Internal:

8. Cut a thin cross section of a raw potato and hold it between your eye and the light. Note the outer skin as above.
9. Notice a layer next to the epidermis from a twelfth to a fifth of an inch in thickness, with a row of little dots (tubes or fibro-vascular-bundles) on the inner portion. This is the cortical portion which turns green when exposed to the light, having chloroplastids and corresponding to the green layer.
10. Note that the remaining, inner portion has two layers, a pithy center layer which, star-like, sends irregular rays into the more solid portion. This pith is sometimes called the "core" or inner medullary area; the latter, the outer medullary area, which contains the greater bulk and food ingredients.
11. Draw to show these four layers. Label. Place an exceedingly small, thin piece under the microscope. Draw cell wall, starch grains, etc.
12. Copy a whole plant from a chart, book or bulletin. (If a whole plant was not given you.) Label fully.
13. After your conclusion, copy the diagram in the Far. Bul. 295, p. 11.

14. Cut an onion lengthwise. Note the small roots springing from a triangular, hard, solid portion at the base which is the stem. Note the leaf bases coming from this stem comprising the greater edible portion. Buds may form between the leaf bases and stem. This whole bud-like structure is a bulb. Draw and label. Compare with the potato.

EXPERIMENT 21.

Obj. To know the potato from the seed to the table.

Oper. For reference see the previous experiment. The Potato, Grubb & Guilford, is the best all-around reference.

2. Potato Growing in Iowa. Ext. Bul. 8, Ames, gives a score card.
3. Cornell Yr. Bk. 1909, p. 575; 532; 1085.
4. See Origin of Cult. Plants, De Candolle, p. 45, Appleton & Co.; also F. B. 295.
5. Plant and Flower Parts, Cyclo. of Ag., Bailey; Plant Physiol., Sachs, p. 58, 330; Root System, F. B. 35; 233. Farmers' Bulletins and Year Books from U. S. Dept. Ag.
6. Seed Potato and Culture Improvements. F. B. 35; 533; 245; 92; 135; 225; 65. Yr. Bk. 1905, p. 415; 1904, p. 46 and 314.
7. Storage, Planting, Care, etc. F. B. 125; 65; 407; 35. Yr. Bk. 1910, p. 24; 1900, p. 339.
8. Fertilizers, Crop Rotation, etc. F. B. 87; 44; 210; 222; 9. Yr. Bk. 1896, p. 114; 1894, p. 123; 1902, p. 523.
9. Disease and Treatments (scab, rot, blight). F. B. 91; 56; 15. Wyoming 71. Yr. Bk. 1905, p. 482 (Formalin for scab).
10. Food, Composition, Cooking, Color, Flavor, etc. F. B. 249; 170; 73; 344; 84; 65; (Starch, Bur. Chem. Bul. 58.) Yr. Bk. 1900, p. 337 and 344; 1899, p. 743; 1904, 429.
11. Yields. U. S. Yr. Bk. 1912, p. 15 and 608. Iowa Yr. Bk. 1910, p. 215 and 100. Potato Growing in Iowa, Ext. Bul. No. 8, Ames. Compare Iowa's corn crop with the potato crop as to bushels value. Compare the average yield per acre in your county with that of other foreign counper acre in your county with that of foreign countries, also with states and other counties. Suggest improvements.
12. Report upon these topics as directed by the instructor.
13. Additional reference on the back of Ext. Bul. 8, Ames.
14. Machinery used in cultivation.
15. Uses made of the potato.
16. How to establish a new variety, etc.

EXPERIMENT 22.

Obj. Which of these exhibits contains the best potatoes.

Oper. Potato Growing in Iowa, Ext. Bul. 8, Ames, p. 46. A score card from the above reference may be used although it differs because no universal scale has been adopted.

	PUPIL'S SCORES									
	1	2	3	4	5	6	7	8	9	10
I. Dealers' Scale. (External Exam).										
Size (20) Perfect										
Too large 2										
Too small 12										
Not even 6										
Shape (10) 10										
Appearance (60)										
Not bright 10										
Dirty 10										
Scabby or wormy 40										
Quality (10)										
Unsound 5										
Brittle or spongy 5										
II. Final Purchase Scale. (Knife examination.)										
Smoothness 5										
Paring thin 10										
Flesh white 5										
Not hollow 5										
Cortical layer thick ...10										
Small centers and not watery 15										
III. Consumers' Scale. (Table qualities.)										
Quick cooking 5										
All cook alike 10										
Mealiness 20										
Whiteness 5										
Grain when mashed 5										
Flavor or taste 5										
Score 200										

Size: Major axis (length) 3½-4 in.
Minor axis (width) 3-3¼ in.
Thickness 2-2¼ in.
Weight 7-8 oz.

Cornell Yr. Bk. 1909, p. 579.

Judges may disqualify the potatoes on the following:

1. Deep eyes, knots, or irregular shape.
2. The color being streaked, mottled, splashed, mixed or over 2% of a different color.
3. Dirty, muddy, barked or skinned, scabby, wormy or rotten or hollow. Generally over 1% rotten, 15% scabby and 25% hollow.
4. Cartons as sacks, etc., not neat, same size, and not securely fastened.
5. White potatoes should score higher than red ones—under variety.
6. To test number III. Place the same number from samples of each exhibit of potatoes under equal conditions in boiling water; boil until done, remove all, take one out of each kettle, let cool; cut to judge mealiness and color which should be white; not creamy, green or black. It should be separated crisply when cut with a knife, and be even thruout. The core should be as mealy as the outer medulla; white, crystalline like, showing fine, white starch grains. Mash under the same conditions; season to suit the taste. Note the grain and flavor.

EXPERIMENT 23.

Obj. Which exhibit has the best oats?

Score card used by the North Dakota Ag. Col., No. 9 Oats.

Scale of Points.	Perfect Score.	Number of Exhibit. 1	2	3	4	5
1. Uniformity—even in size, similar in shape	10					
2. Color—bright, uniform corresponding, to variety type, free from weather stains	15					
3. Size and plumpness: Long, thick, plump, corresponding to variety in size and shape	15					
4. Weight: Standard, 30 lb. per bu.	10					
5. Feeding quality, per cent of husk on kernel, of empty husks, of "pin oats"	20					
6. Dockage, per cent and nature; weight and kinds of dirt, weed seeds and other grain	15					
7. Per cent and kinds of damaged kernels (musty, moldy, bin-burned)	15					
Total	100					

EXPERIMENT 24.

Obj. What per cent of a potato is water? Carbo-hydrates (starch and sugar)? Mineral matter?

Oper. 1. Wash, with a scrubbing brush, a good sized tuber, dry, weigh accurately, record.

2. Remove the epidermis (pare) and place both in a dish for several days, let stand in the sunshine. Why? Of what use is the epidermis?

NOTE.—Results may be obtained in one day if the whole potato is sliced thin and cut into small strips, then dried in a warm, breezy place or by heat.

3. When thoroughly dry, weigh. Compare with the first weight and account for what has happened.

4. Remove most of the starch and sugar by burning in a crucible or by placing in dish on hot coals; cool, weigh. How much starch and sugar, etc., was there? What per cent? How much mineral matter or ash left?

5. Verify your results by consulting reference: Grubb, p. 9, 523 to 528, and Far. Bul. 65, p. 10.

EXPERIMENT 25.

Obj. What are the parts of a stem? How are they associated with graftage?

Oper. Take a cross section of an apple stem, peach, pear, plum or any exogenous stem.

1. Note the bark, wood, pith.

2. Note annular rings or year's growth. The ring, and the wood to the next ring is one year's growth. How old is the stem?

3. Strip a little bark from the wood. The row of cells which join these two is the cambium layer or growing portion. It cannot be seen with the unaided eye. The sap passes down the stem thru the bark and water courses upward thru the wood. In order that the cion may carry on this circulation and receive sap, the cambium, the bark, and the wood of both cion and stem must be together. Other reasons will be discussed in class. Make a drawing to show these parts of the stem.

4. Describe the effect of girdling young trees as done by rabbits.

EXPERIMENT 26.

Obj. How is grafting wax made?

Oper. Far. Bul. 113, p. 13.

A. Rosin, 4 parts by weight (8 oz.)
B. Beeswax, 2 parts by weight (4 oz.).
C. Tallow, 1 part by weight (2 oz.).

If tallow cannot be purchased, get beef-fat, fry out, cool and use, or

	In winter	In summer
A. Rosin	4	5
B. Beeswax	1½	2
C. Linseed oil	1	1½

Melt B and C, then add A. When melted drop into cold water, *slightly* grease hands with tallow or in summer, keep them wet in cold water; pull until light like molasses candy, roll in balls. Soak a ball of No. 18 yarn in the hot wax for tongue grafting. Also, long strips of muslin (5 ft.) of convenient width (10 inches) for wrapping, in budding. When you remove this, place one stick under the center of the muslin, two sticks opposite each other on the outside and run them along, wringer-like, to remove the wax; hang up and dry.

If the wax is too hard, remelt it and add more tallow and beeswax; if too soft, more rosin. This wax may be applied with a brush while melted but not scalding.

EXPERIMENT 27.

Obj. What are the different methods of grafting? When and how should each be applied?

Oper. Reference: Cyclo. Horticulture, Bailey. Farmers' Bul. 79, 114, 238, 113, 133, 659, 30, 118, 124, 153, 218 and 152. The Nursery Book, p. 73, and the Pruning Book, p. 263, by Bailey, MacMillan & Co.

1. One hundred nineteen modes of graftage have been described but they fall into three divisions: (a) Budding; (b) Cion; (c) Inarching. Graftage should be done in the early spring, before the buds start to open, but some authorities say at any time.
2. Budding. Find a healthy bud on a branch, well up and out on the tree, cut crosswise of the stem about one-fourth inch above the bud, slanting towards the pith then horizontally under the bud, and one-half inch below the bud, cut out to surface. Expose the cambium below the bud, along the sides. Make a horizontal, slanting cut on the stem of the stock, in the center and below which make a longitudinal gash into the wood, about one-half inch long. Turn back the corners of the "T" shaped cut, expose the cambium, insert the bud and then turn to their original position. Put wax over all

the bud except the scales; wrap with raffia which remove in two weeks.

3. Cion graftage. The cion should be cut from the last growth on the tree. Cut a whip about halfway up and on the outer branches of the desired fruit stock. Use healthy material. Trim off the end buds which do not use. It should contain three or four buds. On the tree to be grafted, cut off a healthy limb about one inch in diameter, split down leaving the knife therein. Now sharpen the cion wedge-shape, leaving one side of the wedge wider than the other. Quickly insert the cion in the stock, being careful to have the cambium layers meet. Two cions may be placed in one stock. Wind the wax with raffia or waxed cloth, which remove in two weeks. Wax the top of the cion.
4. Inarching. This is used when trees are girdled by accident or by rabbits. Cut small twigs from the tree, sharpen like a cion, slip under the bark above and below the girdle, leaving buds between. It depends on the size of the tree, the number of cions we should insert. Insert two at least, cover with wax all but the bud scales, wrap the bark so as to hold and aid the cions.
5. Whip Graftage: One may dig up wild apple trees in the fall, cut off near the root, leaving a chisel-shaped cut, fit on a cion from a valued tree, bind properly as above, pack in damp sand, and store in a cool place over winter. In the spring this tree may be reset.
6. Make a graft of each kind as described above. (Field exercise. Have the instructor inspect it before placing the wax.
7. Sketch your graftage, telling briefly what you did.
8. The grafting stock and cion should have like pit or seed.
9. Can you graft peaches and pears? Apples and pears? Cherries and peaches? Peaches and plums?

EXPERIMENT 28.

Obj. What is corn smut?

Oper. 1. Draw some smut which is covered by the plant's epidermis. Label epidermis, smut, stalk or flower or ear.

2. Describe the internal structure of the smut mass, how it affects the plant.
3. Draw a minute portion of the smut under the miscroscope, magnified 400 times. Label spores, spines, food content.

NOTE.—These spores may winter-over, sprout, and infect young corn plants when about one inch high. The young tissue or the growing portion is the only source of infection. Destroy all spores masses. The younger the better. There are sporidia and chlamydospores formed. Spores may live over in manure which should not be put on corn plots in this condition.

EXPERIMENT 29.

Obj. Describe oat smut and its preventative.

References: F. B. 225; Plant Diseases, Duggar, p. 374.

Oper. v. Taking a drill of standing oats, count the good stalks and the smutted stalks, make an estimate of the per cent smutted.

2. If Iowa's oat crop amounts to $45,685,916, figure the loss on this average. Wisconsin's is about 7 million dollars; Illinois, 10 million. If Iowa's loss averages 8 per cent, figure the total. The total U. S. loss is placed at 20 million dollars.
3. Draw a smutted stalk. Does the fungus effect the "husks" (palets and lemmae)? Kernel? Straw, Leaves?
4. Mount some of the mass under the microscope. Draw and describe. Compare with corn smut.
5. Preventative: Spores remain in the "husks" which cover the seed, and if the seed is sprinkled with 1 lb. formalin mixed with 50 gallons of water "until moist enough to pack in the hand," put in a pile and covered for two hours or more until ready to sow, the spores will be killed. These spores germinate, grow up thru the oat stalk, "stunt" it and produce new spores for offspring.

NOTE.—There is a hot water treatment. Immerse seeds in water at 130 degrees F. for 10 minutes, etc.; also put 1 pt. formalin to 30 gal. of water; lower in a gunny sack for 10 minutes dry and store.

EXPERIMENT 30.

Obj. What is a potato scab and how is it prevented?

Reference: Plant Diseases, Duggar, p. 292.

Oper. 1. Obtain some scabby potatoes, note the size, color and nature of the scabby spots. Draw to show those of different sizes and stages—some broken open, some closed.

2. It is difficult for an amateur to take out spores and mount under the microscope. They are so small, etc.
3. The spores may live in the soil several years and several scabby potatoes spread the disease to a bin of good ones.
4. Control: (a) Plant clean tuber; (b) rotate crops; (c) Immerse the "seed" for two hours in a solution of 1 oz. formalin to 2 gal. water.

EXPERIMENT 31.

Obj. What are some methods of plant propagation? Describe five methods in detail that you employed.

Oper. Runner: Strawberry. Note from what part of the strawberry this springs; its roots. How many plants from the same runner? Cut off the runner from a plant and re-set the plantlet.

2. Stolon: Black raspberries. Bend the tips of the cane in the fall, insert in a hole punched in prepared soil, cover, packing the soil well around it. Leave the soil loose on top. Find some that are developed. Describe.

3. Cutting: Grape, Willow, Currant, Wandering Jew. Cut off some old cane, bury a node (where a leaf has been) in deep sand. This shows well if the lower ends are placed in a glass jar of water for several weeks. Describe your results.

4. Buds: Potatoes, Tiger Lily. Note the black buds in the leaf axils of the lily, especially in the latter part of July. Plant them on the surface of damp soil. Cut out some buds of tubers and put them in a damp soil in a covered glass dish.

5. Slips: Coleus, Geranium. Where part of the plant has branched or forked, cut off one of these branches, insert, the lower end in 3 inches of sand or soil kept well dampened.

6. Leaf: Begonia. Place the petiole of a begonia leaf in damp sand in a covered jar.

7. Rhizone: Fern or Quack Grass, Stooling (Wheat, etc.) Take an underground stem commonly thot of as the "root" of a fern or quack grass. Cut this into portions, leaving the knots or nodes on each piece. Place in damp soil. Visit a wheat or oat field and note the stooling.

8. Root: Sweet Potatoes, Rhubarb. Place a sweet potato in moist soil. Watch the development from time to time.

9. Bulb: Onions, Tulip, Water Lily, etc. Place the lower part (stem) of an onion thru a hole in a cardboard which is placed on a dish filled with water. Be sure and keep part of the onion in water.

10. Suckers: Plum, Redberry, Tomato. Remove one of the suckers and place the lower end in two inches of damp soil.

11. Spore: Corn Smut, Bread Mold. Place some damp bread in a jar. Sow on some spores of bread mold, keep covered. You may put spores of corn smut on young parts of young corn plant.

12. Seeds: Beans, etc. Plant beans and watch the parts develop and sketch from time to time.

13. Fruit: Corn. Plant corn "seed," watch the embryo develop, sketch from time to time. What becomes of the exocarp and endosperm?

14. Take six of the above given by the instructor and place them in proper condition. Record dates and tell briefly all changes. Draw where possible.

NOTE.—Most of these will be shown best if placed in a glass covered jar.

EXPERIMENT 32.

Obj. How does a judge score corn by aid of a score card?

Oper. Reference: Manual of Corn Judging, A. D. Shamel, p. 28, etc. Orange Judd & Co., N. Y., about 50 cents; also Corn Judging, by Sholsman. Corn, Bowman & Crossley. Corn Secrets, P. G. Holden, p. 42. Corn Culture, P. G. Hoolden, p. 59-74. Successful Corn Culture, P. G. Holden, p. 5-14. Corn Judging, Wooster, 212. Some Lessons from the Corn Shows, Ky., 145. Hints for holding Corn Shows, Ind. Circ. 1. Score Card for Dent Corn, Ohio Circ. 61. Send to your State Corn Growers' Association for score cards, etc. Make a score card and score the ten ears given you.

	Reid's Yellow Dent.	Boone Co. White	Silver Mine
A. Ear—			
Shape	Slowly tapering	Cylindrical	Cylindrical
Length	10 inches	10 inches	9 inches
Circ'mf'r'nce	7 inches	7.5 inches	7 inches
B. Kernel—			
Condition ...	Firm, upright	Firm, upright	Firm, upright
Color	Light yellow	Pearl white	Cream white
Indentation ..	Medium smooth	Rough	Very rough
Shape	Long wedge	Medium wedge	Broad wedge
C. Rows—			
Number	18-24	16-22	16-20
Space	Narrow	Medium	Narrow
Arrangements	Pairs	Pairs	Pairs
D. Butt—			
Filing out ...	Deeply rounded Compressed	Moderately rounded Compressed	Moderately rounded
E. Tip —			
Filing out ...	Reg. rows of kernels	Reg. rows of kernels	Reg. rows of kernels
F. Shank—			
Size	Small	Medium	Small
G. Cob—			
Size	Medium	Small	Small
H. Color—	Deed red	White	White
Percent Corn	88	86	83

The Iowa Score Card.

Points.	EARS									
	1	2	3	4	5	6	7	8	9	10
1. Trueness to type.....10										
2. Shape of ear 10										
3. Purity of color:										
a. Grain 5										
b. Cob 5										
4. Market condition 10										
5. Tips 5										
6. Butts 5										
7. Uniformity of kernels...10										
8. Shape of kernels 5										
9. Length of ear 10										
10. Circumference of ear... 5										
a. Furrows between rows 5										
b. Space between kernels at cob 5										
11. Proportion of corn to cob 10										
Total 100										

KEY TO THE SCORE CARD

RULES

No. 1. Trueness to type: The ten ears should possess like characteristics, true to the variety named.

No. 2. Should conform to the type or variety, tapering slightly from butt to tip, but mostly cylindrical.

No. 3. Color of grain, true to variety and not mixed; white cob should have white corn; and red cob yellow corn. Otherwise cut at least 2 points. For one or two mixed kernels cut ¼ point; for four or more, ½ point. Missing kernels are scored as mixed.

No. 4. Ears sound, matured, firm, dry, free from mold, rot and insect injuries.

No. 5. Not too tapering and well filled with regular, uniform kernels. When the full diameter of the cob is exposed, take off 1 point; if the cob is exposed, cut less in proportion. Consider the shape, size and row—regularity of the kernels on the tip.

No. 6. Rows should extend over the butt in regular order, leaving a deep indentation where the shank is broken. Small, open, swollen or compressed butts are objectionable.

No. 7. Uniform in size, shape, color and true to variety. Their edges should touch from tip to crown. The tip is richest in oil, hence of high feeding value. A full and plump tip is desira-

ble for fattening. The "horny" portion and endosperm contain most of the protein (84% and starch (90%).

Nos. 9 and 10.	Length.	Circumference.
Northern Iowa	8½-9½	6½-7
Central Iowa	8½-9¾	6¾-7¼
Southern Iowa ...	9-10	7-7½

Long ears are objectionable because they usually have poor butts and tips, hence a low percentage of corn.

Add together the deficiencies or excess in length of all the ears not coming up to standard, and cut one point for every inch. In circumference, cut a point for every 2 inches added. Measure the circumference one-third the distance from the butt toward the tip.

Space between kernels near the cob is objectionable; furrows between the rows should be small.

No. 11. To determine, shell every ear, weigh the cobs, subtract from the weight of ears, thus finding the weight of corn. The weight, depth, size of kernels, size of cob and maturity are features of weight. The student may use these facts for his estimate.

EXPERIMENT 33.

Obj. What precautions should be taken in seed corn selection? In its storage?

Oper. References:

1. Iowa Bul. Selection of Seed; 68. Selection, Preparation of Seed Corn; 77; 87.
2. Far. Bul. Selection of Seed Corn, 193. Seed Corn Buying and Judging, 223. Handling of Seed Corn, 244.
3. By Prof. P. G Holden: The A B C of Corn Culture, p. 59. Pub. by Simons Pub. Co., Springfield, O., 1906. Corn Secrets. Pub. by W. Atkinson & Co., Philadelphia, Pa., 25c. (a) Gathering Seed, p. 25. (b) Selecting Seed, p. 47.
4. Successful Corn Culture. Pub. by Success Farming Pub. Co., Des Moines, Iowa. (a) Sowing and Preparing Exhibitions, p. 10. (b) Harvesting and storing, p. 13. (c) Importance of an Ear, p. 56.
5. Corn, Bowman & Crossley, p. 473; other references on pp. 145 and 479. Read any two or more of the references; write a discussion of 200 or more words. Follow this with an outline of your discussion. *Do not copy the bulletins.*

EXPERIMENT 34.

Obj. What is a good method for testing the germination of seed corn? What percentage of the corn tested will germinate or grow?

References:

1. Circ. No. 1 Ia. Mar. 1912, Home Made Seed Corn Testers.

2. The Secret of Testing, Corn Secrets, P. G. Holden, p. 5. Published by the Farm Journal, Phila., W. Atkinson & Co., 1910, price 25c.
3. How to make the Germination Test. The A B C of Corn Culture. P. G. Holden, p. 23.
4 Successful Corn Culture, P. G. Holden, p. 30.
5. Corn, Bowman & Crossley, p. 124-144.

Oper Saw Dust Tester.

1. Make a wooden box of 1-inch stuff 30x30 in. by 4 in. deep.
2. Materials. Sack of pine saw dust, gunny sack or cloth bag. Pail of warm water, 5 yards of (best quality) muslin, stick of wax crayon ("crayola"), 6 tacks, hammer, yard stick, flat stone or brick, pocket knife.
3. Cut a piece of muslin to fit inside the box and extend up the sides for tacking (33x33 in.). Rule this into 2½ in. squares, leaving a 2 in. margin (100 squares in all). Number the squares.
4. Fill half the box with saw dust soaked in a gunny sack over night in warm water or at least for one hour. Tamp and level with the brick.
5. Place the ruled cloth in warm water, wring, lay over the saw dust and tack to the sides.
6. Place the test ears in a row, number on a pine splint forced in the pith of the cob.
7. Begin with ear No. 1 and remove a kernel near the butt, one-third the distance towards the tip, turn the ear one-third around and remove a kernel from the center, turn one-third around and remove one kernel from the tip at one-third the distance toward the butt. Take three other kernels from opposite side of ear from each of those already removed. Lay these six kernels in squares No. 1 in rows of three each, germs up, pointing down or toward one side of the tester. Remove kernels from each ear to be tested until the tester is filled.
8. Cover the kernels with a piece of wet muslin about 42x72 in. Place 2 inches wet saw dust thereon, fold over the edges, pin and set in a warm place, 70° F. off the floor, placing a brick under the upper end. Why?
9. Observe the test after six days, again in eight days. Record and make diagrams of your test.
10. Lay aside the ears that do not germinate, that are weak or the roots and not stems appear; or vice versa.
11. Scald the saw dust and cloths before using a second time. Why?

Rag Doll Tester:

1. Take a piece of good muslin, 8 in. wide and 3 feet long. With "crayola", draw a line thru the center, extending the long

way beginning about 8 in. from one end, lay off 2 rows into 3 in. squares; number the squares in a row, moisten the cloth, set the kernels as in saw dust tester, only have the tips point towards one side, make a core out of paper or wire, roll up the cloth, and kernels fasten with rubber bands, soak in warm water 70° F. for 2½ to 18 hours or over night, remove, set in a warm place, 70° 80° F. for five days by laying the roll flat down across two sticks for ventilation underneath, or place in an empty bucket with the tips down. This is one of the most simple and efficient testers. Scald the cloth before using a second time. NOTE—Be sure to keep the tester damp.

2. Describe completely and accurately just what you did, recording all results with dates.

NOTE—Save the roots for a later experiment. Do not destroy until you have completed the experiment on roots and root hairs.

EXPERIMENT 35.

Obj. What are root hairs? Upon what part of a root are they found? Their functions?

Oper.

1. Germinate corn or squash seeds in sand, or use the seeds from your germination test. Radish seeds germinated between damp papers are good.
2. Float cotton on water in a tumbler, ow thereon timothy seed for microscopic root work.
3. Describe the size, shape, appearance, position and direction of growth of root hairs on the germinating corn. Use a hand magnifier.

For Advance Work:

4. Mount six roots of the timothy in water. Place under the microscope. Find a good hair. Observe.
   A. The single T-shaped cell, wall, protoplasmic granules, nucleus, size, shape, where it joins the epidermis of the root, epidermis of the root. The root hair is an epidermal cell.
5. Draw a root hair and two epidermal cells. Label all parts. NOTE—By running a 10% salt solution under the cover glass, you can see the protoplasmic membrane, which is very important in osmosis.
6. Note that the main root has a cap to protect it while growing thru soil. Note the darker central cylinder of the root where the tubes form and reside to carry the water upward. Make a drawing to show these facts.

EXPERIMENT 36.

Obj. How long is the root system of a corn plant or any other plant? How does its length compare with that of the stem?

Oper.

1. Take an average thrifty corn plant or one from a test in the

previous experiment. Cut off all the branching rootlets, lay them in a line; measure, record.

2. Measure the stem system, compare these two measurements or systems.
3. Is there any part of the root system that you have not taken into consideration or measured? What? Then, is your measurements too large or too small according to what you found in the experiment on root hairs?
4. Make a conservative estimate, comparing all the parts of a plantlet above ground with those below.

References. Far. Bul. 233, p. 5-11. Bergen's Botany, p. 47. Stevens, Intro. to Botany, p. 39, states that the roots of a corn plant, end-to-end, would reach a mile.

EXPERIMENT 37.

Obj. What is osmosis? Explain its use to plants.

Oper.

1. Place the large end of an egg in nitric acid and remove the shell only, about the area of a 25-cent piece.
2. Fasten 12 inches of glass tubing about 5 m. m. in diameter to the small end by aid of grafting wax or sealing wax. Be sure the shell is first cleaned, scrape with a knife or file or wash with alcohol so the wax will stick.
3. Run a sharpened wire down the tube, drill a hole thru the shell into the egg.
4. Place in a glass of water, so the water half covers the shell. Let stand for several days; record from time to time. Sketch-Give your data and draw the apparatus.

   Answer:

   (a) Which is denser, the egg albumin or water?
   (b) In the direction of which density did the passing take place?
   (c) After the passing, did the two liquids diffuse? (Mix.)
   (d) Is there much albumin in the water? What is in the glass tube?
   (e) This membrane allows some fluids to pass thru and not others, therefore, is semi-permeable.

   Combine your answers to a, b, c and e for a definition.

NOTE—This may be done by stretching pericardium or a chicken's crop, etc., over a thistle tube, tied with waxed string, fill with syrup or molasses, place a drop of eosin or red ink on top. Insert this in a tumbler of water. Support and let stand. Diffusion may be shown by putting a drop of eosin solution or red ink in a glass of water.

EXPERIMENT 38.

Obj. How do the soil elements obtain entrance to a plant?

Reference: Soils, F. H. King. Soils, Burkett. Experiment With Plants, Osterhout. Soils, S. W. Fletcher. Far Bul. 266. Cyclo. Am, Ag., Vol. 1, p. 323; 351. Intro. to Botany, Stevens, p. 40

Oper

1. Pull up some of the corn plants raised in sand or in a previous experiment. Why does the sand cling to the roots? Examine with a magnifier. Sketch and label roots, root hairs, sand grains.
2. Draw from memory, a root hair at least one-half inch in diameter and two inches long, give it a porous wall of wood (cellulose), label.
   (a) Make a thin coating of protoplasm near the whole inner wall of the cell. (The protoplasmic membrane.) Shade it thinner towards the center, which is filled with cell sap, thicker or denser than soil water.
   (b) Near and sometimes touching the outer surface, make large irregular soil granules (sand). Between these granules and touching the root hairs indicate soil water ladened with iron, phosphorus, calcium, other necessary elements in compounds and solution.
3. Now from your experiment on osmosis, explain just how soil water is drawn into the root hair.
4. After it enters the root hair, how does it reach the next cell towards the interior. It finally reaches the bundles in the root.
5. There are tubes (fibro-vascular bundles) in the stem to the leaf. Fnd them in a corn stem.

EXPERIMENT 39.

Obj. Thru what part of stems does water pass upward?

Oper.

1. Collect a live apple twig and well matured corn stalk.
2. Set the freshly cut ends in red ink or eosin solution for several hours. Examine thin cross sections as far up as stained.
3. Compare the portions stained.
4. The vascular bundles (tubes) carry the water upwards. Where are they found in the cions? In the apple twig? The sap comes down in the bark of the apple twig, in a different part of these bundles or tube.
5. What kind of stem is the corn as to number of colyledons in the seed? The apple?

   The corn stem has a hard, outer rind; pith, with "string-like" bundles coursing thruout. For further discussion see a botany.

EXPERIMENT 40.

Obj. What are the parts of a leaf? Give a function of each.

Oper. Use a plantain, an elm, a maple, and a clover leaf.

1. Note the "stem" of of the leaf; peiole; the flat part, blade; the base, the apex; margin, along the outlines of the blade; upper side, under side with differences; midrib, blade; and veins. From what do they branch? Sketch the leaf best showing these parts.
2. The clover has three-parted leaf. The maple, a cut or jugged leaf; the plantain, an entire margin. For further leaf study see Gray's Botany.
3. Of what use are the veins? Put the petioles of several leaves, some thin ones, in red ink or eosin solution; let stand, sketch to show your results.
4. Pull the petiole of the plantain leaf slowly apart to see stringy, threads; do not break them. What are these? Use? Where do they end?
5. Place a broken part of this petiole in red ink. Does the solution reach the blade? Why?
6. These are continuations of the vascular bundles in the stem.
7. Trace water from the soil thru the leaf.

EXPERIMENT 41.

Obj. Is starch manufactured in sunlight or in darkness? What effect has each on starch making or photosynthesis?

Oper.

1. Cut several cork discs about the size of a cent and 1/4 in. thick; pin two on opposite sides of a thin leaf, being careful not to injure it. Do this at noon on a sunny day.
2. Pin two other corks on a leaf in early morning.
3. Pick each set of leaves at the close of day, boil in water for a few minutes. Why? Boil in alcohol, note the results. NOTE—Keep it away from the flame as it burns easily. This green is chlorophyll or the coloring material in leaves.
4. Soak the leaves in iodine. Draw and describe your results.
5. Pick a leaf before sunrise, examine for starch.

NOTE—Better results will be obtained if corks are pinned on several kinds of leaves. Some might be pinned on at the close of day. Tomato leaves are good.

EXPERIMENT 42.

Obj. Does a plant excrete the greater amount of water taken in by osmosis? If so, how?

Reference: U. S. Yr. Bk. Ag. 1905, p. 265. Foundation of Botany, Bergen. Elements of Botany, Stevens. Col. Botany, Atkinson. Fungous Diseases, Duggar.

Oper.

1. Heat the air in a fruit jar. Why? Fill two-thirds with fresh green leaves. Place grafting wax or vaseline over the petioles. Why? Seal and let stand one or two hours. Describe the collection on the inner surface of the jar when cooled. What is it?

NOTE—A potted plant may be covered with a tumbler resting on a cardboard, which has a slit for entrance and a hole large enough to contain the stem. External water may be kept out by plugging the cracks with vaseline.

2. Peel off some under epidermis from the leaf of a Canna, Wandering Jew, Geranium or India rubber plant. Mount in water under the higher power of the microscope. NOTE—The openings or the stomata, the two cells, one on each side or guard cells, which fill with water and distend the openings or when their water evaporates, they collapse and close the stomata. The water escapes by evaporation and this depends upon the humidity of the atmosphere, etc.
3. What would be the results of much dust on plants? Smoke and other coverings? Of placing plaster on leaves? Spores of plant disease? Potato blight, etc. send the sprouting mycelium thru these stomata and here fungus diseases enter the plant body.
4. See Exp. on amount of water taken in by roots. What became of that water? Could a plant hold all this water? Why take in so much water?

EXPERIMENT 43.

Obj. What is a good method for making carbon dioxide? What is a good test for carbon dioxide?

Oper.

1. Place one-fourth cup of cider vinegar in a wide mouthed jar or fruit can, insert a teaspoonful of baking soda.
2. Pour the gas, neither the foam nor the vinegar, into another jar and cover. In this jar, pour a spoonful of lime water. (Made by slacking quick lime, pouring on water, letting stand until clear, then pouring off to use.) Shake well, note the effect.
3. Insert a glowing splint in the gas above the vinegar. Note the results.
4. Describe just what you did and just what you saw in logical sequence.
5. Blow year breath thru an ice cream soda straw or glass tube into some clear lime water. Result? What does it show?
6. This is the only known gas that will turn lime water milky.

EXPERIMENT 44.

Obj. What is a good method for making oxygen? What is a good test for O.?

Oper. NOTE—This gas can be made similar to that in the Exp. on carbon-dioxide, if the other apparatus is not handy.

1. Collect the following apparatus, two working together: One spoonful sodium peroxide, a test tube with as much water and a cork with a delivery tube, two small gas bottles filled with water inverted in a pan of water, paper folded around the test tube to hold it.
2. One person should hold the rubber delivery tube under the mouth of the bottle to collect the gas by upward displacement while the other inserts the sodium peroxide into the test tube and corks quickly, holding the cork in firmly. Fill the bottles with gas, cover and remove.
3. In one bottle of gas, insert a glowing splint; in another, lime water and shake.
4. Describe exactly what you did and what you saw; account for each change.
5. If you have had chemistry write out the reaction. Others, see Herick's Chemistry.

EXPERIMENT 45.

Obj. What part of air is O.? Is N.?

Reference: Plant Physiol., Duggar, p. 244.

Oper.

1. Float a piece of wood 1x1x1¼ in. on water filling two-thirds of a pan.
2. Obtain a glass jar with the top and bottom about the same diameter. Measure its contents accurately.
3. Place a piece of red phosphorus, the size of a big pin head, on the stick; ignite; place the mouth of the jar over it letting it rest on the bottom of the pan.
4. When burning ceases and the fumes are absorbed by the water, no carbon-dioxide being given off, place a glass plate over the mouth of the jar while under water, remove, invert. Test the gas. Measure the water.
5. What did the P. burn out of the air? What gas is principally left?
6. Of what did the water take the place?
7. Estimate the per cent of these two gases.
8. What class of plants are N. producers? Name some. How do they produce it? See Exp. on inoculation. What are the two sources of H.? What is nitre? Why is N. necessary to a plant? Can a plant use free N.? Why is protoplasm called a nitrogenous substance?

EXPERIMENT 46.

Obj. What gas is given off during photosynthesis or starch-making in the leaf?

Oper.

1. Place a leaf of a water plant, Elodea or Chara, in fresh water within a glass dish; allow to warm in the sunlight and note the bubbles. Note how they glisten like oxygen. Count the the numbers in five minutes.
2. This oxygen is given off during starch-making.
3. There is a method of collecting this gas, caught in a funnel and lead into a test tube but it is not a very satisfactory demonstration for testing unless pyrogalic acid is used.
4. Record what you did and saw.

EXPERIMENT 47.

Obj. What gas is given off during the rispiration and germination of seeds.

Oper.

1. Fill two-thirds of a jar with soaked peas, on damp paper, cover tightly, allow to germinate, test the gas above them with a glowing splint or lime water.
2. The Exp. can also be performed by placing leaves in a sealed jar and test with Baryta water.
3. Record what you did and saw.

EXPERIMENT 48.

Obj. What is the manner of growth, sizes and shapes of yeast plants?

Oper. Reference: Osterhout, Exp. With Pl., p. 389.

1. Use a compressed yeast cake, yeast foam or any other yeast. In one pint of luke warm water put a tablespoonful of sugar or honey, add one-half yeast cake, which has been rubbed to a paste in water (to separate the plants). Divide the liquid into three parts. Keep it in a temperature 70°-90° F. Necks of the bottles stopped loosely with cotton. Note and record every change, giving time, bubbles, turbidity, etc.

NOTE—Wishing more accuracy, in 250 C. C. of water put 10 grams cane sugar or honey, insert 5 gms. yeast prepared as above. Add 100 C. C. of this water at 98.4° F. Shake, set aside 100 C. C. of this solution as above.

2. After a few hours, mount some of the sediment or liquid and place under the microscope. Note the old, dead cells with cracked wooden walls; the little, young plants budding from parents. The small granules of protoplasm in the joining yeast cells, and the cell wall.
3. Run some Muthyl Blau—greenish stain—under the cover glass. This will stain the woody walls of dead cells, but not living healthy cells.

4. Compare the dead cells with the living; is the yeast of good quality?
5. If the yeast action is prompt soon after preparation, the quality is good. Did it act quickly? NOTE—Yeast may multiply by spores similar to corn smut.
6. Describe the use of yeast in (a) fermentation; (b) bread making; (c) value to the country in dollars.
   If you cannot see the cell wall, run glycerine or 20% salt solution over the specimen.

SOILS

The instructor should assign those experiments which are best adapted to his course and class. It is not intended that all should be performed.

EXPERIMENT 49.

Obj. How many kinds of minerals in this vicinity? How may I tell each?

Oper. Excursion 1.

1. The instructor should take the class to a sand bank, gravel pit or dry creek bed, gather the different minerals, place them in paper bags, or better, in cloth bags made in a sewing class; label all specimens in the field, bring to the laboratory for further study. It does not matter if two or three are united in a rock.
2. Fill out the following table for each mineral: Color, lustre*' smell, taste, feel, hardness, fracture*, acid test*, special, name. NOTE—For elementary or ninth grade work, omit those marked*.

Color	Lustre No.*	Smell	Teste	Feel	Hardness	Fracture No.*	Acid Test No.*	Chem. Comp. No.*	Special	Name

Luster: Held so the light is reflected from the surface; glossy, silky, resinous, waxy, etc.

Hardness: The scale passes from 1 to 10. Talc or soapstone is 1; diamond, 10; quartz, 7; back of the point of a knife is about 5; glass, 5½; brass pin point, 3; finger nail, 2½; 7 and 8 are neither scratched by a knife or by quartz.

Fracture: Note a broken surface, smooth, splintery, etc.

Acid Test: Place 2 drops of nitric acid thereon and if it effervesces, calcium is present.

Reference: Rock and Min., Paisson, p. 327-378. Key to Min., Crosby.

Rocks and Minerals in this vicinity:

Amphibole.
Apatite (Cal. Phos.).
Biotite (Mica).
Chert or Flint.
Chlorite.
Dolomite.
Feldspar.
Granite.
Greenstone—Chert, Feldspar, Quartz, Calcite, Hematite.
Gypsum (Cal. Sulph.).
Hematite.
Iron Pyrites (Fool's Gold).
Jasper.
Kaolin.
Limestone.
Limonite.
Muscovite.
"Nigger Heads.
Orthoclase.
Plagioclase.
Porphyry=Quartz+Feldspar.
Quartz.
Sandstone.
Serpentine.
Shale.

EXPERIMENT 50.

Obj. How many rocks are found in this vicinity and how may I know each?

Oper. 1. With sacks and hammers take an excursion to the sand bank, creek beds and stone piles. Collect specimens of each, label and take to the laboratory.

2. Fill out the following table: Name, volcanic or sedimentary, minerals composing, color, sperial.

NAME	Volcanic or Sedimentary [See a Geology]	Minerals Composing	Color	Chem. Comp.	Special

EXPERIMENT 51.

Obj. From what and by what is soil made?

Oper. 1. Phys. Geog., Chamberlain and Salsbury. Darwin, Theory of Vegetable Mold. See a Geol. or a Phys. Geog.

2. Discuss the part that the following take in soil making: Minerals, Rocks, Weather, Winds, Streams, Plants, Burrowing Animals, Earthworms, Glaciers and Man.

3. Write a composition on this topic after reading in a text. Do not copy the books.

4. Cite evidences of these on the excursion.

EXPERIMENT 52.

Obj. What are the kinds of soil in this vicinity and a cause for the formation of each?

Oper. 1. Make an excursion to the different soil areas of the vicinity, collect samples and bring to the laboratory.

2. Briefly describe the excursion.

3. If dry, grind between two sticks to separate; better use the soil while damp. Rub between the fingers for grit. Fill out the following table: Name, location, source in nature, color, taste, odor, texture, shape of particles,, plasticity, price per A. (estimated), acid test.

Name	Location	Source in Nature	Color	Taste	Odor	Texture

Shape of Grit and Particles	Plasticity	Price per A (Estimated)	Acid Test

Location—Where you found it.

Source—From what and by what formed.

Odor—Moisten before smelling.

Texture—Grains, granules, lumps, fineness of particles.

Shape of particles—Use a hand magnifier.

Plasticity—Mix with a small amount of water, compare with clay.

Price—Inquire. For agricultural purposes only.

Acid test—Put soil in a glass or earthen jar, place thereon two or three drops of nitric acid. Effervescing shows lime.

Soils:

Coarse gravel	Soil or humus	Clay.
Fine gravel.	Sub-soil.	Loam.
Coarse sand.	Geest.	Sandy loam.
Fine sand.	Hardpan.	Silt, etc.

EXPERIMENT 53.

Obj. How may I distinguish humus, sand, silt and clay under the microscope?

Oper. Reference: Ele. Ag., Warren, p. 78.

1. Use gumbo (the best), humus, silt, clay, or all three.
2. Description:
   a. Color—White, gray, brown, red, black.
   b. Shape of particles—Angular, rounded, irregular, etc.
   c. Grains—Simple, compound.
   d. Size of grains—Coarse, medium, fine, very fine, etc. (See text.)
3. Mount in water, a very small amount of gumbo on a slide cover, etc.
4. One division on the lower part of the micrometer eyepiece is one sixty-fifth m. m. on the high power, one two hundred fiftieth m. m. A micron or "Mu" is a millionth of a meter. Microscopes will vary. With the newer microscopes, low power, eyepiece 10, read the micrometer scale and divide by 6. For the high power divide by 25.
5. Draw to show quartz, humus, silt, kinds of sand, clay, different rock, particles, etc. Measure and state the diameter of each in microns.
6. Describe the appearance of each as seen under the microscope.

EXPERIMENT 54.

Obj. What soil elements are found in a cup of rich garden soil? Give the per cent. of each.
Ref.: Cornell Yr. Bk. Ag. 1910 p. 952.

Oper.

1. Take a leveled glassful of dry, rich garden soil.
2. Separate the pebbles if there be any. Weigh.
3. By aid of sieves separate the sands as far as possible. Weigh. For advanced work only:
   These may be measured by the micrometer scale in the microscope; some by a ruler. For the low power, eyepiece 10, read the scale and divide by 6; for the high power, divide by 25. This will enable one to distinguish the different sands, etc. Be sure that neither humus nor roots of any kind are kept with the sand, etc.

4. Place the remainder in a fruit can, 1-3 filled with water, shake for 5 minutes, pour into a flat dish, let the clay settle for 5 minutes. Dry it and weigh.
5. Pour off the top and evaporate the silt and humus left. Dry and weigh.
6. The humus may be burned out by heat. Did humus settle in the clay? How do you know? Burn dry clay; color? What color does humus give to the soil?

Pebbles 5-2 m. m.
Gravel 2-1 m. m.
Coarse sand 1-.5 m. m.
Medium sand .5-.25 m. m.
Fine sand .25-.10 m. m.
Very fine sand .10-.05 m. m.
Silt .05-.005 m. m.
Clay .005-0.
Humus, size varies.

EXPERIMENT 55.

Obj. What is a good method for classifying gravel and sand? What are the classes? Sizes? Percents of each?

Oper. Warren, p. 78. NOTE.—It is best to work three samples taken from the top, middle, and bottom of the pile. Screens or sieves may be obtained from the Cent. Sci. Co., Cambridge, Mass., 20-40-60-80-100 meshed. A mesh is the distance between two adjacent wires—20 meshed is 20 meshes to the inch.

1. Weigh 40 grams of very coarse sand. Dry by heat.
2. Measure with a metric ruler, the particles of gravel, or use the sieve; sort out and weigh all more than 1 m. m. in diameter. Label and record.
3. Measure, sort out and weigh the particles of coarse sand.
4. Run the remainder thru the sieve, separate into lots, place samples under the microscope, measure the largest and the smallest, classify, weigh and record. If you have no microscope, treat the screenings as sand, and the remainder as silt and clay. Record each and find the per cent.

EXPERIMENT 56.

Obj. What is capillarity? Upon what does it depend?

Oper.

1. Fasten two glass plates or microscopic slides together by a rubber band or string. Insert a broom splint along one long vertical edge.
2. Set one-fourth inch of the base or one end in water stained with red, black ink, or eosin. Describe what happens. Sketch.

3. Increase the space between the glasses. Is the water drawn higher? Dry the glasses.
4. Press the glasses closely together and determine this effect on capillarity. Draw a conclusion.
5. Experiment to see if capillarity will work horizontally as well as vertically. Place water along the edges; along the top. Describe what you did and what took place.
6. Capillarity may be shown by the end of a lamp wick, blotter or a cube of loaf sugar placed in red ink. It can be shown with glass tubes and straws inserted in water which is drawn above the common level.
7. Answer: What would be the nature of the soil particles in which capillarity brings the water highest? Lowest? What would be the effect on the capillarity of rolling or packing the soil. Explain: How would it effect the soil in dry weather? How does capillarity aid plants in dry spells? Toward what does it always act?

EXPERIMENT 57.

Obj. How many kinds of moisture in the soil and where does each reside?

Oper. Ref: Rural Sch. Ag., Davis, p. 108. Ele. of Ag., Warren. Far. Bul. 408.

1. Record your results by a table.
2. Tie cheese cloth over the small end of a student's lamp chimney; weigh. Fill one-third with air-dried soil; weigh. Record weight of the soil.
3. Pour the soil in an evaporating dish, heat for 15 minutes to half an hour at a boiling temperature or until the weight is constant. *Do not burn.* This drives off the hydroscopic water which can be driven off in no other way. Pour the soil in the chimney; weigh. What per cent hydroscopic water? It should be about 10 per cent. This water surrounds the particles and could not be removed by evaporation unless heated to 212° F.
4. While the above is drying, you may take an equal weight of the same kind of soil and place it in the chimney or later use the absolutely dry soil. Firm the soil by jarring it, hitting the hand three or four times on the table, etc., or by punching with a wire so there are no large spaces. Do not pack.
5. Place in a rack or support. Pour water thereon slowly so it does not stand on the surface to any great extent, until it begins to seep thru or becomes saturated. When it ceases dripping measure the gravitational water which gravity drew downward only thru the large pores.
6. Weigh the chimney and wet soil. How much capillary water remained in the soil? This lies between the soil grains, also surrounding and in the small pores.

7. Gravitational or free water moves downward only; capillary, up, down and sidewise, but generally towards the dry area. Hydroscopic has no movement and can be removed only by heating and passing off as steam. Record your result by this table.

Name of soil	
Weight of chimney	
Weight of chimney and soil	
Weight of chimney and soil after heating	
Weight of dried soil	
Weight of dry soil	
Weight of hydroscopic water	
Weight of chimney soil and cap. water	
Weight of capillary water	

8. Is the hydroscopic water included in the capillary? Of what value is gravitational water? What becomes of it? How does it aid capillarity? In what direction does capillarity act? Can a plant use all of the hydroscopic water? All of gravitational water? How may gravitational water become harmful?

EXPERIMENT 58.

Obj. Which soil examined has the greatest capillarity? Of what use is capillarity?

Oper. Ref. Far. Bul. 408, p. 40. Yr. Bk. 1905, p. 269.

1. By means of strings or rubber bands, fasten pieces of muslin 4x8 in. over the small end of a student lamp chimney (common chimneys will do.) Weigh each chimney and place in the racks.
2. Take dried, coarse sand, fine sand, "soil" and clay loam, or any two of the above. Roll out the lumps (run thru a 20 mesh sieve), fill all large air spaces by pummeling down with a wire or jarring on the table. Do not pack but fill the chimney level full. Weigh.
3. Place the cloth-covered end in empty tumblers. When ready, record the time and fill all the tumblers at the same time with water. Record the measurements from the bottom of the chimney.
4. Record your observation by table until the water reaches its final height. Remove the tumblers, let drain, weigh, record.

Chimney	Soil	Hght. 1st ½ hour	3 Hrs.	6 Hrs.	24 Hrs.	48 Hrs.	Etc.
1st							
2nd							
3rd							
4th							
5th							

NOTE.—Observation may be taken at other convenient times.

4. If necessary, one may use tomato cans with nail holes in the bottom.
5. Answer: In which does the water rise most rapidly? Highest? Which draws up the greatest amount? Which would dry out soonest? Which would be best for plants during a drought? Why?
6. The instructor will further demonstrate the height by aid of large, long tubes.

NOTE.—The above weights may be used in an experiment following.

EXPERIMENT 59.

Obj. What effect does cultivation of soil in dry weather have upon the capillary water?

Oper.

1. Set a cube of loaf sugar in a saucer.
2. Place as much confectionery or pulverized sugar on the top as it will hold.
3. When ready, pour a little red ink in the saucer. Describe the results. Account for each. You may use bluing or any colored ink.
4. In a cultivated field, to what is the loaf sugar comparable? The pulverized? The red liquid? What draws the liquid up the loaf sugar? Effect of pulverizing soil on the capillarity? Effect of packing? The effect of cultivating corn before or during a drought? Why cultivate just after a rain? In dry farming, why till an unsowed field all summer?

EXPERIMENT 60.

Obj. What effect has tillage and mulches on evaporation of water from soils?

Oper.

1. Fill nine-tenths of four tin cans equal in size, with dry sand. Number, weigh and record.
2. Pour an equal amount of water in each. (20 oz.)

3. Pack number one; place some finely cut straw-mulch on number 2; place a dry dust-mulch on number 3; sow oats two inches deep, in number four.
   Weigh again and record.
4. Weigh and record each day for one week or until results are obtained.
5. Be sure to give all the cans the same exposure to heat, light and wind. Why?
6. Record your results by a table. Explain.

EXPERIMENT 61.

Obj. What effect upon the texture has tilling the soil when it puddles?

Oper. Far. Bul. 408, p. 41.

1. Use clay, loam, sand and peat or any other four soils (gumbo, etc.)
2. Take one level cupful of each soil, mix separately with water until it puddles or pours like mush.
3. Let stand for 15 minutes then pour off the free water and stir again.
4. Dry over a slow fire for several hours or in the hot sunshine.
5. Which soil baked? Which could be most easily cultivated after drying? Which cultivated soonest after a rain? Which never cultivated when wet? Which will be "earliest" in the spring?

EXPERIMENT 62.

Obj. What effect does packing the soil have upon its capillarity?

Oper.

1. Take four cloth-closed chimneys of humus.
2. Pack two tightly with soil and leave two properly but loosely filled.
3. Place the cylinders in the rack with the lower parts in tumblers of water.
4. Note the rapidity of capillarity by recording the height of moist soil in each every half hour.
5. What bearing does this have on farm practice?
6. Discuss rolling of fields; packing the soil on top of seeds; packing around set-out plants as cabbage, etc.

EXPERIMENT 63.

Obj. Which one of these soils has the greatest capacity for holding water? Ref.: F. B. 408, p. 39. Yr. Bk. 1905, p. 268.

Oper.

1. Four work together; record all work by a table.
2. Use gravel, fine sand, "soil" (humus) and clay loam or any three different soils that are easily obtained.
3. Weigh the chimneys with strings and cloths. Record.
4. Fill 7/8 of the three chimneys with the three soils. Weigh and

determine the weight of the soil in each. Observe the precautions in a previous experiment for loosely filling.

5. Have three students with a measured amount of water (4 oz.) ready; also a time-keeper.
6. Record the time, all pour together, keeping the soil surface just water covered. When it drips thru, cease pouring and record the time and water used together with the name of the soil.
8. Cover the surface of the soil to prevent evaporation; let stand until dripping ceases which will be several hours—sometimes 24 hours or even three days—then weigh. Watch to determine which holds the most water. Tabulate all records.
9. Which took water the fastest? Which the most porous? Which holds the most water? Which contains the smallest particles.
10. Describe how each of these soils cares for rain water during a light shower; a heavy shower.
11. How can this capacity be lessened by a farmer? Can it be increased?

EXPERIMENT 64.

Obj. What effect does the interruption of capillarity have upon the soil?

Oper.

1. Fill two-thirds of a lamp chimney with garden soil, place about one-half inch of grass, straw or the like, then fill with the soil; cover the ends and rack the chimneys.
2. Fill another chimney with the soil, etc.
3. Place the ends of these in glasses of water, at the same time, let stand until results are obtained.
4. What effect does plowing under a thick sod of clover have on the crop following? Plowing under tall weeds? A thick coat of manure? Straw? How is this difficulty overcome?

EXPERIMENT 65.

Obj. Does the same volume of different soils have the same weight? Why?

Oper.

1. Weigh four cups, number and record each.
2. Take a heaping cup of each, loose humus, sand, clay and loam under the same conditions, as to water, packing, lumps, etc.
3. Level the cups (but do not pack) by running a straight-edge over the rim of the cups.
4. Weigh each and figure the weights of the soil; compare.
5. Which is the heaviest? Why? Lightest? Why? What advantages has light soil? Heavy soil? How does the farmer overcome these disadvantages?

EXPERIMENT 66.

Obj. What effects has lime and humus on the water content of clay?

Oper.

1. Punch holes in the bottom of three tin cans, weigh and record each, or use student lamp chimneys.
2. Fill them as follows: No. 1 with clay; No. 2 with clay mixed with plaster or lime; No. 3 with clay mixed with humus or rotting manure.
3. Weigh each and record.
4. Place an equal amount of water on the soil of each until it drips thru; cover to prevent evaporation, let remain until drippings cease. Record the amount of water used and the weight of each.
5. Which retained the most water? Took it most readily? Gave it off most readily? Of what use is this to the farmer?

EXPERIMENT 67.

Obj. What per cent of this soil is water? Organic matter? Mineral matter?

Oper. Ref.: Ele. of Ag., Warren, p. 75. Soil, Hopkins, Soil, King. Soils, Burkett. Far. Bul. 408.

1. Use freshly collected soil or humus.
2. If different members of the class will use different soils and compare results, greater knowledge will be gained.
3. Some work with soil, some with sub-soil.
4. Two or more work together.
5. Record your results by a table.

	WEIGHT
Dish or crucible	
Dish and soil	
Soil	
Dish and dry soil	
Weight of dry soil	
Per cent of water	
Dish and soil (after burning)	
Organic matter	
Per cent of organic matter	
Weight of mineral matter	
Per cent of mineral matter	

6. Use about 40 grams of freshly collected soil. (NOTE.—The more the better.)

7. When drying, heat a little hotter than boiling for one hour, or more if necessary. (Do not burn.)
8. To burn the organic matter, heat to a dull redness for one hour. NOTE.—If you have no crucible, dry in a tomato can; burn out the organic matter in an iron shovel, over red coals.
9. Give the changes in color that took place in drying and burning. Account for each change.
10. Which holds the more water? The more humus? What relation do these bear to each other? Which has the most mineral matter? What was the only substance that heat would not remove?
11. The results generally given are: (a) Mineral matter, 55-75%; (b) Organic, 2-5%. (c) Water in: Sand, 20-30%; rich sandy loam, 30-40%; rich clay loam, 40-60%; heavy clay, 60-70%; garden soil (rich in loam), 70-90%; dust (air dried), 10% good corn soil, 25%. Best growth soil has about one-half water.
12. Verify your results.

EXPERIMENT 68.

Obj. Is there air in the soil? If so, what per cent? Which contains more air, damp or dried soil?

Oper. Ref.: Far. Bul. 408. Soils, Burkett.

1. In a glass tumbler, place a measured amount of damp soil (200 c. c.) filling seven-eights of the glass. In another glass, place an equal amount of measured dry soil of the same kind.
2. If you have a thistle tube, insert this, and pour the water therein so the water will reach the bottom first; but it is not necessary. This may be done by making openings in the soil.
3. Continue pouring a measured amount of water on or in the soil until it begins to stand on the surface. How much water did you use?
4. Do the same with dry soil.
5. Why did "bubbles come out of the soil?" Of what did the water poured in the soil take the place? Which would contain the more air space, soil composed of fine particles or large particles? Why?
6. Fill out this table.

	SOILS	
	Wet	Dry
Weight of		
Volume		
Water added		
Air space		
Per cent of air		

7. Add the per cents you obtained in the experiments to show mineral matter, humus, water and air. How much should this equal? Why?

EXPERIMENT 69.

Obj. Will roots and plants live without soil air?

Oper.

1. Place a Tradescantia (Wandering Jew) stem in packed clay in a glass jar. If needs be, pour paraffin over the top to shut out air.
2. In jar No. 2, place another plant in damp sand, not paraffined, but having an air hole in the bottom of the jar. Let stand until results are noted.

NOTE—This may be shown by sowing wheat in two boxes; one with air openings in the bottom; the other closed and soil air crowded out by water keeping the soil "marshy".

EXPREIMENT 70.

Obj. Which soil has the greatest per cent of air space,, sand humus (soil) or clay-loam?

Oper. Ref.: F. B. 408, p. 40.

1. Pleace a measured amount of each soil in a glass. (It is better to weigh the glass, the soil and the water.)
2. Pour the water on each as in a previous experiment, recording just the amount of water used each time (by weight); weigh each soil after it is filled with water.
3. Of what did the water take the place?
4. Record your results by a table and verify them by a previous experiment.
5. How is it posible for equal volumes of these soils to have unequal amounts of water? Explain. What relation does this bear to agriculture?

EXPERIMENT 71.

Obj. What effects has air-slacked lime on plastic soils?

Oper.

1. Weigh out six samples of clay, 300 grams each. Divide as follows:
   No. 1—Add no lime as a check.
   No. 2—1 gram of lime.
   No. 3—5 grams of lime.
   No. 4—10 grams of lime.
   No. 5—10 grams of medium sand.
   No. 6—10 grams of humus.
2. Mix each thoroly; then add a very little water, enough to make it plastic. Roll each sample into three mud balls of about 100 grams each. Set aside to dry.
3. Test the resistance or tenacity of each by one of the following methods. (Record all results by a table.)

(a) Fix two sticks like a nut cracker, and decide on the relative power to mash the balls.
(b) Drop the balls at a given height and compare to see which is the hardest.
(c) Place under a board, stand on the board and see which breaks easiest.
(d) Try to break particles with the fingers.

4. Of what value is this information to a farmer in tilling soil? Explain.

EXPERIMENT 72.

Obj. What is a good test for lime? How is lime prepared?

Oper. Ref.: U. S. Dept. Ag. Circ. 195, p. 15.

1. Use a small piece of stone thought to contain lime. Bone and marble are good.
2. Place a drop of nitric or sulphuric acid on it. Use precaution with acids—poisonous and "burns". If it gives off bubbles of carbonic acid gas, lime is present; otherwise none, or it is not good limestone to use.
3. Burn in a stove for a day, a stone containing lime; when thoroly burned, remove.
4. To test it, you may mix this lime with water and when the water settles, pour off and blow your breath into it with a straw. Carbon dioxide turns clear limewater milky.

EXPERIMENT 73.

Obj. What effect has lime on flocculation of soils?

Oper.

1. Fill one-half of each of two glasses with rain water (100 c. c.). Place in one, ½ gram of slacked lime. Add to each tumbler one gram of powdered clay (sifted thru a 100 meshed soil sieve). Stir well, let settle.
3. Pour off the water; examine the sediment in each from time to time. Good soil has small compound particles about the size of timothy seed.

EXPERIMENT 74.

Obj. What effect does a nutrient solution have upon sprouting corn?

Oper. Ref.: Col. Bot., Atkinson, p. 29. Plant Physol., Sachs.

1 Soak a cupful of corn in warm running water over night; remove, sprout between damp cloths. Four students work together.
2. Carefully plant ten sprouted seedlings in soil.
3. Dip paper in melted paraffin, let cool; fill a glass tumbler with distilled water, cover with the waxed paper, tie down. Punch holes therein, place roots *carefully,* so they dip in the distilled water.
4. Set up the following like this only vary the solution. Cover

glass jars with black paper or cloth to prevent green algae growing in your solution. *Keep the jars filled.*

6. Use tap water.
7. Use nutrient solution without iron.
9. If you wish, you may omit one of the food substances as potassium nitrate and see how it effects the plant.
10. Label and let stand in proper conditions until results are obtained. Tabulate your results. You may weigh the plants when you finish, etc.
11. You may experiment further by setting up sprouted peas under different conditions, leaving a food element out of four tumblers but four which has all the elements.

EXPERIMENT 75.

Obj. What is a good test for an acid? An alkali? A neutral?

Oper.

1. Tap water, vinegar, lime water, litmus paper which can be purchased at a drug store or you may use cochineal.
2. For lime water, slack one-half cup of quick lime in one pint of water, let settle, pour off the clear liquid for use. This may be refilled several times.
3. For cochenial, which is the bodies of dead insects, place a teaspoon of pulverized powder in a small bottle two-thirds filled with alcohol. This liquid is called the "indicator". When dropped in acid it turns reddish brown; if dropped in alkali, a purple blue. Add a few drops to the substance to be tested.
4. Record by a table. Place the tip of the red litmus peper in each of these in this order: lime water, water, vinegar.
5. Likewise place the blue litmus paper in vinegar, water, then lime water
6. Leave the litmus paper blue; rinse, dry and save.
7. Test the following at home and tell whether acid, alkali or neutral.

Ammonia	Soap or saltpeter	Tomato juice
Soap	Sugar	Orange juice
Sour milk	Tooth preparations	Apple juice
Sweet milk	Ashes or lye	Rain water
Magnesia	Dutch cleanser	Ink
Baking soda	Tea	Sugar, etc.
Coffee		

EXPERIMENT 76.

Obj. Are the specimens of soil given us acid, alkali or neutral. Give a good method for testing.

Oper. Ref.: U. S. Dept. Ag. Circ. 195, p. 21.

1. Boil a tablespoonful (the more the better) of the soil to be tested in a small amount of water. Let it settle, pour off the clear liquid, test with both colors of litmus, leaving the litmus

in the solution for 10 minutes, if necessary. For colors, see previous experiment.

2. NOTE—The teacher may prepare alkali soil by mixing with Dutch cleanser or ashes; acid, with acid or vinegar or collect acid and alkali coils in the field.
3. Another method of testing is simply to cover both colors or litmus paper with the dampened "mushy" soil, let stand over night; if both are red, the soil is acid; if both are blue, it is alkali. It will generally act in 15 or 20 minutes.

EXPERIMENT 77.

Obj. How may I remove acidity from the soil? ("Sweeten sour soil.")

Oper. If an acid soil is not at hand, prepare one as in the previous experiment, or test it to make sure.

1. Take a cupful of damp, sour soil and stir in lime, testing it from time to time until it shows neither acid nor alkali but neutral. No harm if it is slightly alkaline because you can use it in the following experiment.
2. Wood ashes will serve the same purpose as lime.

EXPERIMENT 78.

Obj. How may I make an acid substance neutral? (Neutralize an acid.)

Oper.

1. Take a small amount of vinegar and dilute with water until it just stands the acid test. Dilute some lime water until it just tests alkali.
2. Pour a very little lime water (diluted), very slowly, into the vinegar, stir well, test; continue until the solution is neither acid nor alkali (neutral).
3. How may a farmer treat acid or "sour" soil? If you spill acid on a cloth, what is best to do? Name some acids? Some alkalis?

EXPERIMENT 79.

Obj. Does moisture effect the temperature of soil? If so, how?

Oper.

1. Suspend from a board two thermometers that register the same. Place a small covered cup of water near one and run a lamp wick from this to and around the bulb of the other.
2. Record the temperature of each for five hours of the day. Use a table.
3. Answer: Is a wet or dry soil preferable for early vegetables? What would be the composition of such soil? The effect of a wet season upon early garden truck? How can a farmer remedy this defect? NOTE—This may be performed with soil dampened but not so successfully.

EXPERIMENT 80.

Oper.

Obj. Does color effect the temperature of soil? If so, how?

Oper.

1. Fill properly, three small boxes with damp garden soil. Chalk boxes will do.
2. Cover the surface as follows: (a) Chalk dust (white); (b) soot, lamp block or charcoal (black); (c) brick dust (red); (d) natural. n
3. Insert a thermomether one inch below the surface and record temperature of each. Take several readings; day and night; sunshine and cloudy.
4. Record your result by a table. NOTE—Seeds may be planted in these boxes and results observed.

EXPERIMENT 81.

Obj. Does the slope effect the temperature of soil? If so how?

Oper.

1. Fill three boxes with garden soil.
2. Slant one thirty degrees from the horizontal toward the north, another thirty degrees toward the south; the third keep horizontally.
3. Test the temperature as in the previous experiment by inserting a thermometer one-half inch in the soil.
4. Take observation several times in one day. Record by a table.

EXPERIMENT 82.

Obj. How may alkali be removed from the soil?

Oper.

Oper. If an alkali soil is not at hand, use that from the previous experiment or mix soil with lime, potash or wood ashes until it tests alkaline.

1. Punch six nail holes, near the center, in the bottom of a tin can. Fill two-thirds with a tested alkaline soil and set this can in another dish.
2. Pour water on top of the alkaline soil, let it seep thru; test the seepage with litmus. It it contains alkali the drainage is carrying the alkali from the soil.
3. Alkali soil of irrigated countries and of the west are made neutral by running water over it and draining the alkali underneath.
4. Account for alkali on the surface of soil.

EXPERIMENT 83.

Obj. What are the soil areas of our State and Country?

Oper. References: Soils of Iowa, Bul. 82. Ames. Geol. of Blackhawk Co., Prof. M. F. Arey. U. S. Bureau of Soils, 1902-1903, p. 861, with maps. Soil Fertility, Hopkins, p. 90.

Geo. Map of Iowa, F. A. Wilder, 1906; State Geol., Des Moines. Outline Maps, J. S. Latta, Cedar Falls, Iowa. Iowa Yr. Bk. of Ag., 1912. Bul. 95, Ames; also 15 and 119.

1. Consult Bul. 82 or other reference or wriet from lectures.
2. Name the soil areas with formation of each.
3. Briefly describe the soil of each.
4. Describe the soil of your home county.
5. Name five of the best farming counties. Five of the poorest. Which are the best for Corn? Melons? Orchards? Fruit? Celery? Potatoes? Market gardening? Wheat and graes? See Iowa Yr. Bk., 1912.
6. On a blank outline map, sketch, color and label all the soil areas.
7. On another map, indicate the answers to the questions above.

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DAIRYING

EXPERIMENT 84.

Obj. What are the parts used in judging a milch Cow?

Oper. Reference: F. B. 106. Ele. of Ag., Halligan, D. C. Heath & Co. Judging Live Stock, Craig, Kenyon Pub. Co., Des Moines, Iowa. Elements of An. Husb., Craig, Webb Pub. Co.

1. Study the parts of a *live cow.* Have students paste a picture of a cow in their note books, or outline one by tracing a cow cut from pasteboard, or from tin. The teacher should point out the parts, having the students label and recognize each.
2. Head: Poll, horn, ear, face, muzzle, mouth, lower jaw, cheek, eye, lids, lashes, etc., forehead, neck.
3. Body: Dewlap, brisket, shoulder, withers, chest, girth, chine, back, ribs, barrel, milk veins, and wells flank stifle joint,,nand back, ribs, barrel, milk veins and wells, flank, stifle joint, thigh, loin, hip or "hook" bones, rump, "pin" or thurl bones, tail, tail setting, fore-udder, teat, hind-udder, eschutcheon.
4. Limbs, etc.: Fore libs, forearm, knee, leg, hoof, hind limb, hock, shank, tail, switch.

EXPERIMENT 85.

Obj. What are the external characters of a good cow?

Reference: Judging Live Stock, Craig, p. 87.

Oper.

1. The class should inspect a good dairy cow and their attentions be called to the points which are shown by the score card in the experiment following.
2. Each member of the class should draw a good cow or paste a picture of some prize cow in his book and tell why it is good.

EXPERIMENT 86.

Obj. What does this cow score?

Oper. Ref.: Warren, p. 343 (Ele. of Ag.) Craig, p. 76. Ohio Circ. 135, p. 85. Read Course for Farmers, No. 25, Cornell.

1. Score a cow by use of this score card.

CORNELL UNIVERSITY,
COLLEGE OF AGRICULTURE.

Score Card.

DAIRY CATTLE.

Scale of Points—Cow.

	Perfect Score	Points Deficient: Stud. Est.	Points Deficient: Est. Cor.
General Appearance—			
Weight, estimated.....lbs.; actual.....lbs.			
Form, wedge shape as viewed from side and top	5		
Quality, hair fine, soft; skin mellow, loose, medium thickness; secretion yellow abundant; bone clean	10		
Constitution, vigorous, not inclined to beefiness	8		
Head and Neck—			
Muzzle, clean cut; mouth large; nostrils large			
Eyes, large, bright			
Face, lean long; quiet expression	7		
Forehead, broad, slightly dished			
Ears, medium size; yellow inside, fine texture			
Neck, fine, medium length; throat clean; light dewlap			
Fore and Hind Quarters—			
Withers lean, thin; shoulders, slightly oblique	3		
Hips, far apart; level between hooks			
Rump, long, wide, level	5		
Pin bones or thurls, high, wide apart			
Thighs, thin, long	2		
Legs, straight, short; shank fine	1		
Body—			
Chest, deep, low; with large girth and broad, well sprung ribs	10		
Abdomen large, well supported; with moderately high flank and large umbilicus	5		
Back, lean, straight; chine open. Tail, long, slim, with fine switch	4		
Loin, broad, level	2		
Milk-secreting Organs—			
Udder, long, attached high and full behind; extending far in front and full; quarters even	16		
Udder, capacious, flexible; with loose, pliable skin covered with fine, short hair	14		
Teats large, evenly placed	4		
Milk veins, large, tortous; large milk wells; escutcheon, spreading over thighs; extending high and wide; large thigh ovals	4		
Total	100		

Perfect Score Student's Points Deficient

Animal .....Date .....

Student.....Standing .....

NOTE.—For bulls omit points under udder, etc. Make allowance for masculinity head, neck withers, size, etc.

EXPERIMENT 87.

Obj. How is the Babcock milk test performed?

Reference: Ele. of Ag., Warren, p. 345, also foot note p. 332. Modern Method Test Milk, an Slyke, p. 42.

Oper.

1. Fill out this table:

Reading at the top of butter fat column	
Reading at the bottom of butter fat column	
Per cent butter fat	
Butter fat in 50 lbs. milk	
Butter in 50 lbs. milk	
Value of the butter today	
Is it lawful milk?	

The specific gravity of the acid should test between 1.82 and 1.83 at 60° F. Strong tests at 1.84. Use commercial acid.

THE BABCOCK TEST FOR BUTTER FAT IN MILK.

Utensils: A hand power centrifugal tester, at least two milk test bottles, one pipette to measure the milk, one acid measure, about one pint of sulphuric acid, a few ounces of milk, and some hot water. All the necessary apparatus and acids can be purchased for about five dollars from any dairy supply company. They can be ordered thru a hardware dealer. Sulphuric acid is sold also at drug stores.

Sampling the milk: The milk to be tested should be thoroly mixed just before the sample is taken to make sure that the fat or cream is evenly distributed. This can be done best by gently pouring back and forth between two vessels several times. The milk should be neither very hot nor cold. Place the small end of the pipette at the center of the milk and suck the milk up above the 17.6 c. c. mark. Quickly put the index finger over the upper end of the pipette and by releasing the pressure allow the milk to run out until its upper surface is even with 17.6 c. c. mark when the pipette is held straight up and down. Place the point of the pipette a short distance into the test-bottle neck, holding it against the glass and with both pipette and bottle at an angle. Remove the finger to allow the milk to flow into the bottle. Be sure to get every drop of the milk, taking care to drain the pipette and to blow the last drop into the bottle. A little practice should make anyone proficient with the pipette. It is best always to make this test in duplicate; hence two bottles are needed for each lot of milk.

Using the acid: The acid is very strong and must be handled with great care. If any gets on the hands, face or clothing, it should be washed off quickly and water should always be ready for

this purpose. Do not leave the acid where young children can get it. *Never use the pipette for measuring acid.* Do not pour acid in tin and iron receptacles—use glass or earthen. After all the samples of milk to be tested have been measured the acid should be added. Fill the acid measure to the 17.5 c. c. mark with acid that is neither very cold nor hot. Pour this into the bottle in a slanting position. The acid will then carry down any milk left in the neck and follow the glass surface to the bottom of the bottle and form a layer under the milk. Hold the bottle by the neck and give it a circular motion for a few minutes, mixing the milk and acid until no milk or clear acid is visible. By this time the contents will be dark colored and hot. This change is due to the acid dissolving all the solid constituents of the milk except the fat, which it does not affect.

Whirling the bottles: The bottles are whirled to separate the fat so that it can be measured. They should be hot when whirled. If necessary, they may be heated by standing in hot water before being put into the machine. A steam machine is easily kept hot when in use. Other kinds should have boiling hot water placed in them. Place the bottles in the machine so that each one will have another directly opposite, to keep the machine in balance. Whirl the bottles five minutes at the proper speed for the machine in use. (Generally count, "a thousand-one," "a thousand-two," etc., and give the crank one turn at each count or once a second.) Then stop it and with the pipette or other convenient means, add hot water to each bottle until the contents come up to the bottom of the neck. Whirl again for two minutes. Add enough hot water to bring the top of the fat nearly to the top of the graduations on the neck of the bottles. Whirl one minute. The fat should then form a clear column in the neck of the bottle.

Reading the percentage: Keep the fat warm so that it will be in a fluid condition. Hold the bottle by the upper end of the neck, letting it hang in a perpendicular position, on the level with the eye. Read the mark or graduations at the extreme top and the bottom of the fat column. The difference between these is the percentage of fat in the milk. Most test-bottles are made to read as high as 10 per cent. Each per centage has its number marked on the glass and there are five small spaces each representing .2 per cent between these principal marks. Thus, if the top of the fat column is even with the third short mark above the 7 mark, the top reading would be 7.6; and if the bottom is half way between the first and second short marks above the 3 mark, the bottom reading would be 3.3; the difference is 4.3, which is the percentage of fat or number of lbs. of fat in 100 lbs. of milk tested.

Notes: 1 c. c. means 1 cubic centimeter or about 20 drops. If the

fat column is clouded with white specks, probably the acid was not strong enough, or not enough was used, or the heat was not high enough. If with dark specks, the acid was too strong, too much used or the heat too great. Always keep the acid bottle closed when not in use. Clean the bottles while warm with warm water. Do not let stand until cold. Observe a skim-milk bottle and a cream bottle for testing. Tell just how each differs from the milk bottle. State standards of Iowa for milk: Solids, 12%; butter fat 3%; cream, 16 per cent.

The student may separate skimmed milk and cream if he wishes. To reduce butter fat to butter, multiply by 1 and 1-16.

EXPERIMENT 88.

Obj. Does prompt cooling of freshly drawn milk effect its souring? If so, how? Why?

Oper.

1. Divide a sample of freshly drawn milk into two equal parts (1 cup).
2. Cool one by setting it in ice-cold water.
3. Let the other stand in the temperature of the room.
4. After the first has cooled sufficiently, let them both stand under equal conditions. Taste from time to time and record when each sours.

EXPERIMENT 89.

Obj. What care should be given to milk utensils?

Oper.

1. Take two bottles, bake one for 1 hour. Cork while hot, cool.
2. Insert ½ cupful of freshly drawn milk in each; cork and see which sours first, and the time required.
3. Pour the milk from each of the above jars. Wash one in cold water only. Do not scald or wipe, leave exposed to open air to dry.
4. Wash the other in cold water, then scald and wipe clean, invert to keep from open air.
5. Place ½ cupful of freshly drawn milk as before. Record the time for souring, etc., as before.

EXPERIMENT 90.

Obj. Which jar contains watered milk?

Oper.

1. A cylinder of water; one of good, sweet milk; one of watered milk which the instructor has prepared. Number each. Take the temperature of each.
2. Place a N. Y. Board of Health lactometer in the water, record the reading. Add .3 for every degree above 60° F..; subtract .3 for every degree below 60° F.

3. Place the lactometer in the other two jars and take the readings of each, corrected.
4. Detect the watered milk. Could milk when slightly watered, be detected?

EXPERIMENT 91.

Obj. What per cent of this milk is solids? Per cent solids not fats? Per cent fat?

Reference: Mod. Meth. Milk Test, Van Slyke, p. 133. A Dairy Lab. Guide—Ross, p. 30, Orange Judd Co.

Oper.

1. Make a Babcock test.
2. Use a Quevenne lactometer which gives the Sp. Gr. Each division is 1°; every fifth degree is numbered.
3. Fifteen degrees of reading equals 1.015 Sp. Gr.
4. To correct for temperature: For every degree above 60° F. add .1° to the reading at 60 which the instrument records; below 60° F., vice versa. Do not test milk until two hours after it has been drawn.
5. Place the milk to be tested in a cylinder, lower lactometer therein, read, adjust for temperature. The lowest limit for the Sp. Gr. of milk is 1.029; normal milk is 1.030 to 1.034.
6. L=reading of lactometer. F—Per cent of fat.
7. Formula to determine per cent of solids in milk. S. N. F. $(\text{Solids not Fats}) = \frac{\text{L}+.7\ \text{F}}{3.8}$
8. Estimate the per cent. Subtract the results of your two formulae.
9. Estimate the total solids.

EXPERIMENT 92.

Obj. How may I test milk for foreign substances, preservatives, etc.? Annatto, Coal-tar dyes, Sodium Carbonate, Formalin.

Ref.: U. S. Dept. Ag. Bu. Chem. Bul. 100, p. 52. Formalin, borax, p. 44.

Oper. The instructor prepares specimens numbered, etc.

1. Test for annatto: 10 c. c. of milk in a t. t. add 10 c. c. aether; shake well, let stand until aether rises to top A yellow color in the aether shows annatto—the deeper, the more coloring.
2. Coal tar dyes (Azo colors): 10 c. c. milk added to 10 c. c. strong H Cl; mix, a pink color shows azo colors.
3. Formalin: "Freezine," "Iceline," 2-6% formalin. 10 c. c. milk in a test bottle or test tube; add 5 c. c. sulphuric acid, very slowly, so the acid tends to stay on top. Do this by letting it run down the side. Formalin shows as a marked violet ray between acid and milk when a few drops of iron sulphate is added.
4. Sodium Carbonate: 10 c. c. milk added 10 c. c. alcohol and a few drops 1% sol. of resolic acid. Pure milk shows a brownish yellow: carbonates rose-red color.

EXPERIMENT 93.

Obj. How may I separate "oleo" from pure butter?

Oper.

1. Heat some skimmed milk, add one-half taespoonful of the sample to be tested. Stir with a wooden splint until all the fat is melted. Cool by allowing faucet water to run against the side of the jar. Stir until the fat hardens. Butter, fresh or renovated, solidifies in small particles, scattered thruout the milk and cannot be collected in one mass and lifted out like the oleo. NOTE.—It is best for the instructor to have two samples, one pure and one mixed to see if the student can detect each.
2. You may weigh each and estimate the per cent.

EXPERIMENT 94.

Obj. What is the appearance of milk under the microscope? What parts can you distinguish?

Ref.: F. B. 29, p. 5. F. B. 348, p. 14. F. B. 42. Yr. Bk. 190, p. 180.

Oper. Place a small drop of milk on a slide, cover with a cover glass, place under the microscope, find the fat globules with the low power. Examine with the high power.

1. Note the fat globules, size, shape, number, some gathering and forming cream. Measure with the micrometer scale, eyepiece 10, divide by 25 for the real size. Estimate the number in a sq. m. m. Draw to show several sizes; they are not hollow like bubbles. They are globules of fat. Can you see the water? Bacteria?
2. The fluid part called serum consists of milk except *fat*. The other constituents are dissolved in the water and are principally sugar, casine, (albumin) and mineral matter in small quantities. Sugar is the chief compound but not very sweet. After burning, phosphates, chlorides or soda, potash and lime. It is said that a single drop of milk contains millions of globules and if a person should count 100 per minute, 10 hours per day, 6 days in a week, it would take ten years to count all in one drop. Different breeds have different size globules. Jersey probably has the largest and for this reason the cream rises quickest.

				Held in Solution		
	Water.	Fat.	Casine.	Albumin.	Sugar	Ash.
Milk	...87%	3.6%	3.3%	0.7%		0.7%
			Nitrogenous			

3. Draw under the microscope:
   (a) Cream.
   (b) Good milk.
   (c) Skimmed milk.

EXPERIMENT 95.

Obj. Does this cow pay for her keeping?

Oper. Copy the following table, weigh the milk that some cow gives, test it, weigh her feed for one meal, figure the cost, etc., per month. If you cannot do this, estimate and use this ration per day. F. B. 222, p. 13. Prices will vary as rations will vary.

Ration.	Lbs.	Cost per T.
Timothy	10	$10.00
Dry fodder	10	3.00-5.00
Corn cob meal	3	20.00
Wheat bran	4	22.00
Gluten meal	4	20.00
Linseed meal	1	30.00

A FARM MILK RECORD.

Month ..... Year ..... Owner's Name

Cow's Name, Bess. Weight .....

DATE	A. M.	P. M.
June 1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
Total A. M. and P. M.		
Total milk		
Test		
Lbs. fat		
Lbs. butter fat times 1 1-6		
Value		
Interest on investment		
Value of feed		
Total		
Gain or loss		

Figure all the cow gives you in fertilizer, skimmed milk and calf to pay you for your services, but charge her for her feed and interest on her value, as $100 for 30 days at 6%.

EXPERIMENT 96.

Obj. What does this butter score?

Ref.: Short Course Class Notes, No. 15, p. 7, Ames.

Oper.

1. Have several packages of different butter:
2. Score according to this score card:

	Perfect score.
Flavor	45
Color (should be uniform thruout)	25
Body (meaning texture)	15
Salt (including quantity and evenness of mixture	10
Style (reference to the package)	5

Good butter should have a nutty flavor and leave a creamy, clean flavor in the mouth.

Flavors:

Flat—Unripened cream or lack of salt.

Rancid—Overripening of cream or ripening at an improper temperature.

Cheesy—Improper washing; a failure to remove casine.

Weedy Bacterial development improper feeding.

Acid—Incomplete washing.

Stable—Unclean surroundings.

Metallic—Rusty cans? (Bacteria).

EXPERIMENT 97.

Obj. How may I distinguish the different feeds for dairy cattle?

Oper.

1. Collect specimens: Linseed meal, cotton seed meal, oil cake, gluten meal, corn meal, ground oats, wheat, bran, oat bran, silage, etc., or whatever farmers are feeding in the vicinity.
2. Read the process of milling in bulletins, books, etc., or visit a mill.
3. Analyze the feed and fill the following table. Wt. per quart, color, texture, taste, protein, carbohydrates, crude material, nutritive ratio, digestibility, mastication, etc.
4. Under protein, etc., look in the tables at the back of the text. (Warren, Ele. of Ag.)

EXPERIMENT 98.

Obj. How may I distinguish oleomargarine and renovated butter from genuine?

Reference: F. B. 131, p. 7.

Oper.

1. A kerosene lamp and a tablespoon.
2. The instructor should place colored "oleo," renovated butter and fresh butter in three numbered jars before the students.
3. "Oleo" and renovated butter boil noisily, sputtering like a mixture of grease and water when boiled, produce no foam

or but very little. Renovated butters produces usually a very small amount.

4. Genuine butter boils usually with less noise (but sputters if heated too fast), and produces an abundance of foam. When uncertain, give the butter the benefit of the doubt.
5. Test each and record.

EXPERIMENT 99.

TOPICS TO ASSIGN FOR REPORTS.

1. Dehorning calves and cows.
2. Different breeds of milch and beef cattle. Name the distinguishing characteristics, size, colors, etc.
3. Best breed or breeds for dairy; dual type, comparisons of records from farmers' cows of each type.
4. Best breeds for beef, records, cost, profit, etc.
5. Stanchions, stables, drops and platforms.
6. Feeding troughs, racks, calf pens, yards, sheds, granary farmgate.
7. Two plans for a dairy barn, ground and elevation.
8. How to construct three kinds of silos; precautions, the best.
9. Silage preparation, feeding qualities, compared with other feeds, amount to feed a cow per year. How to figure the contents of a silo.
10. The milk house, milking utensils (structure, care and use), cream, churn, milk testers, scales.
11. Operation of a separator and milking machine.
12. How, what and when to feed: (a) milch cow; (b) steers. Give a balance ration during two periods for each.
13. Does a cow pay? Table showing the milk she gives each milking for a month, etc., as shown in a previous experiment which see.
14. Milk, use of testing, testing associations, method of, lactometer.
15. Milk, cause of souring, cautions, composition, value as a food, care of delivery, bottle and pail, pasteurizing, etc.
16. Kinds of bacteria, Coci, Bacilli, Spiryllum, Butryic acid: alkaline, stringy, soapy, blue and bitter milk.
17. Contagious diseases scattered by milk. How spread, preventions, poisonous preservatives, butter coloring.
18. Butter as a food compared with "oleo." Oleo, how made, use, kinds, value?
19. Cuts of beef, relative price and food values.
20. Elementary principles of cooking each; stakes and stews.
21. Veal as food, "Bob" veal. Compare with beef and mutton.
22. By-products from a slaughtering house. Name and uses of each. See Am. Cy. Brit., Vol. 106.
23. Cheese making at home. Method.
24. Butter making complete, ripening the cream, etc. How to renovate butter and tell the same.

POULTRY

EXPERIMENT 100.

Obj. What are the parts of an egg and the use of each?

Oper.

1. Bring a pot of water, enough to cover the eggs, to a boil; remove from the fire, insert the eggs, let remain for 45 to 50 minutes for hard boiled. If you wish, you may boil for 3 or 4 minutes if in a hurry. Drop in cold water after boiling to prevent turning black.

Reference: Warren, p. 368.

Unboiled:

1. Place each end of an egg in the hollow of your hands, try to break. The particles of the egg are arched so as to give them strength.
2. Place a magnifier on and draw a small portion of the surface. Label, pores, particles of the shell, pigment or color.
3. Place in a little nitric acid; account for the result. Mix some limestone and nitric acid.
4. Break an egg in a saucer but do not break the yolk; crack in the center, then open.
   (a) Note, germinal disc, an oblong mass of white material which develops into a chick—near the yolk.
   (b) Chalaza—whitish cords holding the yolk in albumin.
   (c) Albumin.
   (d) Air space. In which end of the shell?
   (e) Two membrances around the air space. Do they cover the whole contents?
5. The vitellene membrane surrounding the yolk.
6. Draw, showing these parts, then puncture the vitellene membrane; describe.
7. Hold a fresh egg before an egg tester and see what parts you can make out. Use a boiled egg.
8. Peel the shell from the large end so as to preserve part of the outer membrane, air chamber, shell, etc.
9. Cut the hard boiled egg lengthwise thru the center.
10. Note the fatty yolk floated on the albumin and the germ lies on the yolk.
11. Note two colors of yolk, lighter next to the germ.
12. Note the chalaza ("hammock") holding the yolk in place; Vitellene membrane.
13. Perhaps you may note the two layers of albumin. Draw to show these facts.
14. Note the little pores in the shell. Some will show pigment or coloring particles.
15. Try to break an egg by grasping the ends in the palms of

your hands and squeezing. If you have a thin, acid-eaten portion of the shell or filed portion, you can see by aid of a magnifier the small lime particles put together like the arch in a bridge. This gives the shell its strength.

EXPERIMENT 101.

Obj. What part of an egg is shell? Albumin? Yolk?

Oper.

1. Weigh an egg.
2. Boil it hard; dash in cold water.
3. Remove the shell, weigh; also the yolk and white.
4. Record all by this table. Your result is approximate. Why?

	Weight	Fraction Part	Per Ct.
Egg	.....	.....	.....
Shell	.....	.....	.....
White	.....	.....	.....
Yolk	.....	.....	.....

EXPERIMENT 102.

Obj. What precautions should a person take in sorting eggs for marketing? For hatching?

Ref.: Cornell Rural Sch. Leaf. 1913, p. 29. U. S. Yr. Bk. Ag. 1912.

To prepare museum specimens:

1. File the ends of an egg until each shows grey; puncture, blow thru a tube inserted in the opening of the large end, until the contents are blown out. Mount the eggs on a cardboard, with glue, for further use. Give data: breed, date, fowl, weight, etc. Instruments for this work can be obtained from Ward's Nat. Museum, Rochester, N. Y., 25c.

Oper. Size, weight and form:

2. Select six large, fresh eggs, six medium and six small ones.
3. If one small egg weighs (....., student weighs one), how much will a dozen weigh?
4. If eight eggs should weigh a pound, what should one egg weigh? A dozen?
5. Weigh a dozen assorted eggs. How much does one weigh? Weigh one and see if you are correct. Why vary?
6. Weigh one dozen small eggs or figure weight of one dozen from one egg. What part are you losing when you buy small eggs? If correct size eggs sell for 30 cents, and you buy the small ones for 30 cents, do you gain or lose and how much? What per cent? What should be a correct price to ask for that dozen of small eggs when proper sized ones sell at 30 cents? Eight eggs should weigh a pound. NOTE.—The teacher may present many other problems here.

7. Note the difference in form; sort so as to present the best appearance. Show the different shapes as elliptical, round, elongated, etc., by drawing one of each.
8. Among six small eggs, place several big ones. What precautions should be taken in marketing? Describe the appearance.
9. Colors: Compare the colors of diffierent eggs. Arrange the eggs so they grade from a white to a dark brown. Place brownest and whitest side by side. Note the contrast. Group the eggs of the same tint or shade; also size. Note how much darker a tinted egg looks by a pure white than by a brown. Sort out six of each, keeping the sizes, colors, etc., the same as near as possible. New York demands white eggs; Boson, brown.

Shell texture:

10. Note that some of the eggs are glossy, some smooth, some rough, thick and thin shelled. These differences are due to breed characteristics and may be determined to tell the fowl that laid the egg. If the shells are thin, it shows a lack of lime in the food and improper feeding. Do not use such for hatching as they will not produce strong chicks. Use only eggs perfect in size, shape, color and texture which are characteristics of the breed. A pure-bred is more liable to lay such an egg and they sell for a higher price. A hen is liable to lay an egg like the one from which she was hatched.
11. Name the precautions in sorting for hatching.
12. Cleaning and packing: Clean by washing with a damp cloth. Washed eggs do not keep so well but lay them aside for family use. Cartons for packing can be purchased from companies or made as handiwork. Place so the small end is down. Sawdust, bran, oats, etc., may be used or a mixture of bran and powdered charcoal is excellent. Keep clean and cool. Never put eggs in water. Infertile eggs keep best; therefore, "swat the rooster" after you have finished saving eggs for incubation. Pack infertile eggs if possible.

EXPERIMENT 103.

Obj. What is a good method for preserving cheap eggs for later use?

Water glass. Silicate of Soda Method.

Oper.

1. Preserving months: April, May and June.
2. A clean jar, 15 dozen of infertile, good sized, clean, fresh eggs from clean surroundings.
3. Ten quarts of clean boiled water, cooled; one quart of water glass, mix; stir until thoroly mixed. Keep clean. It may be mixed 1:15.
4. Pack clean, fresh, uncracked eggs in the stone jar, large ends up; pour water-glass solution over until completely covered about 2 in. above the eggs.

5. Cover tightly to prevent evaporation and keep in a temperature less than 60° F. (In a cool, dry, clean cellar.)
6. Never use the liquid the second time.

NOTE.—A few eggs may be preserved in a quart fruit jar, mixing the water glass one part to ten of water.

Second method: Dip eggs in a solution made by dissolving 2 oz. gum arabic in one pint of cold water. Let them stand to dry, then pack in powdered charcoal.

Third method: ("Lime pickle.") For large quantities. Lime 1 bu., slack in water; table salt, 3 lbs., cream of tartar, 1½ lb., water to form a mixture so an egg will float thereon. (About half barrel.) Keep eggs in this liquid. It is said that they will keep two years; or, to every pail of water, ½ lb. salt and ½ lb. slacked lime, 1 oz. niter or of salt; insert eggs therein small end down. Better anoint with lard to prevent brittle shells, etc.

Fourth: (Coating.) Coat the eggs over either with 8 oz. beeswax melted with 1 lb. of olive oil or with melted paraffine; then put them in lime pickle or charcoal.

Fifth: (Bran.) Mix 8 measures of bran with 1 of powdered quicklime which is very good for preserving while transporting.

Rules: 1. Do not store fertile eggs.
2. Poor eggs will not keep even if packed.
3. A broken egg stored with good ones endangers the whole packing.
4. Keep the large end up.
5. Observe cleanliness.

EXPERIMENT 104.

Obj. What is a good method for testing eggs?

Reference: Am. Cycl., Vol. 6, p. 523, and F. B. 585, p. 14.

Oper. Number some good eggs and some bad eggs by labeling on the shell. Record. Give these to the pupils mixed and let them decide. Also have at hand eggs of different ages.

1. Mix 1 lb. (pint) water with 2 oz. salt. Test by inserting the egg. It is said that this liquid does not harm eggs.
2. Fresh—1 day old—stay below the surface; 3 days old—just immersed, but older ones float. Two weeks or more, float with just a little of the shell in the water.
3. Candle a poor egg and a good one to see if you are correct.

EXPERIMENT 105.

Obj. What is a good method for candling eggs? How may I tell the following kinds of eggs: Fresh? Stale? Fertile? Infertile? Partly incubated? Heated? Blood ringed? Mixed rots? Black rots Mold spots?

Reference: F. B. 594, p. 3, also F. B. 585, p. 14 (Home Made Tester.) Yr. Bk. Ag. 1912, p. 345. Yr. Bk. Sep. 596, p.

347. Int. Cycl., Vol. 6, p. 523. Prod. Polt. Husb., Lewis, Tester on p. 343, 439. U. S. Dept. Ag., Bur. Chem. 51. How to make an egg container, F. B., p. 6-7. Ladies Home Journal Jan. 1915.

Oper. Choose one of these forms of testers: One that comes with an incubator: purchase one of a company selling incubators. You may take a round piece of cardboard, paint it black inside and out or put black paper over a lamp chimney. Make a box with a base 8x12 or more inches, ventilate, if a lamp is used; use an electric light if possible. Cut holes thru trap doors slanting along the sides, a little smaller than an egg and on a level with one's eye. Arrange so the flame is just back of the hole over which the egg may be held with the large end up. Have a good, strong light.

1. Fresh eggs are clear and have the air space nearly filled. Hold a fresh egg in front of the flame.
2. Stale eggs have more air space in the larger end; very stale eggs have about one-half air space. Some say that the air space grows $\frac{1}{8}$ inch for every day.
3. Fertile eggs have a dark germ spot; infertile, none. Break an egg and note a germ spot, if present. Decide first by candling.
4. Partly incubated eggs show after three or four days. Use some eggs which have been incubating three or four days. Note the blood rings. Large black eyes of the chick, etc.
5. The shell is very porous and sometimes spores of moulds are forced thru and there grow, forming a "kind of bread mold" which looks like black spots in eggs. Bacteria may do the same, causing rots, etc.
6. When first set, good eggs look clear with the germ and yolk. After three days the allantois membrane or breathing apparatus is formed. After seven days, the stomach, brain and limbs can be seen. After eleven days, the feathers and large eyes can be seen. After fifteen days, the bill opens and shuts; handle sparingly.
7. Make drawings of eggs to show as many of the above facts as possible. Label fully.

EXPERIMENT 106.

Obj. What precautions should be taken in sorting and caring for eggs during incubation?

Oper. Cornell Bul. 282, p. 417. F. B. 236, 585, 128. U. S. Yr. Bk. Ag. 1912, p. 347. Rural Sch. Leaf. Cornell 1913. Prod. Pol. Husb., Lewis, Lippincott, Phila.
Nat. & Art. Brooding, F. B. 624; Nat. & Art. Incub., F. B. 585. Stand. Var. of Chicks, F. B. 51.

1. Sort and prepare eggs as instructed in a previous experiment.

2. Write out the following outline. Do not copy Bulletins but write from memory.

A. Intro.:

1. Reasons for sorting, etc.

B. Dis.:

2. Parts of an egg and location of each.
3. Fertility and upon what it depends.
4. Vermin, mice, lice, etc.
5. Health and exercise of parents.
6. Feed and care of parents.
7. Mating numbers.
8. Care of cock.
9. The eggs—size, shape, color, thickness, weight, freshness, storage, care.
10. Position in incubator, number, temperature, cooling, dryness, air currents, why turn, etc.
11. Setting different breeds together.
12. Periods of incubation with factors governing.
13. Delayed hatching, cooling and re-incubation.
14. Why combine hen and incubator? Value of each?
15. What per cent is a good hatch?

C. Con.:

EXPERIMENT 107.

Obj. What is a good method for boiling eggs?

Reference: The Boston Cook Bk., p. 199, Little Brown & Co., Boston.

Oper.

1. Use six fresh eggs.
2. Slightly crack one; pierce the larger end with two or three small holes to keep the interior intact. Number the eggs from one to six.
3. Bring to boil enough water to cover these eggs, remove from the blaze, insert the egg, let stand 5 minutes. Remove No. 1 after 5 minutes standing; No. 2 after 10 minutes; No. 3 after 15 minutes; No. 4 after 20 minutes; No. 5 after 25 minutes. Remove the cracked one after 20 minutes standing.
4. Dash each of 1, 2, 3 and 4 in cold water as soon as removed, remove all the shell, cut thru the center for inspection. Let No. 5 cool in the shell. Inspect as the others. Why dash in cold water?
5. Which one is soft boiled? Hard boiled? Which has a "mealy" yolk?
6. Did the interior come thru the cracked egg? Why?

EXPERIMENT 108.

Obj. What will this dozen of eggs score?

MARKETED EGGS.

Name of student .....Breed of fowl.....Weight of doz. .....

	Points	Score
Freshness (30)		
Size of air cell, perfect, is 1/8 of an inch or less in depth. Take off five points for each eighth inch more in depth. Use the tester	20	.....
Natural shell, lustre; lack of same due to washing or age is a serious defect	10	.....
Weight (20)		
Weight of perfect sample, 24 oz. or more, per dozen. Cut one point per dozen for each ounce under weight. Overweight is no defect.	10	.....
Uniformity of sample. All eggs should weigh the same	10	.....
Color (20)		
Color of whole sample should be either pure white or pure brown. If creamy or tinted with color they are counted defective. Dark brown being better than light brown	10	.....
Uniformity—All the eggs should be of the same tint. Note the average color and cut one point for every egg that is off color	10	.....
Shape (10)		
Egg shape. The large diameter should be almost 1 1-5 times the smaller	5	.....
Uniformity. Cut a point for every egg that varies from the average shape which measure	5	.....
Appearance (10)		
Clean, should not show dirt or blood stains. Take off 1/2 point for every unclean egg	5	.....
Uncracked and unbroken. Cut a point for each cracked or broken egg; but if the contents leak out, do not score further as they are disqualified; the same if more than five are cracked...	5	.....
Condition of Shell (5)		
Take off a point for each rough shelled egg. If the shells are thin, they cannot be shipped desirably and are counted defective	3	.....
Package (5)		
Should be neat and attractive. Lightness, durability	5	.....
Total	100	.....
Score the eggs given you.		
Student's score	.....	.....

EXPERIMENT 109.

Obj. How may I tell the different parts of a feather?

Oper.

1. Take some good quill feather from a hen or other fowl.
2. Note the quill or central part that possesses no feathered portion. How was it fastened to the hen? Examine a hen to see. Can you see the line where it was fastened? Is it solid or hollow? Why? Uses made of quills?
3. Note the extension of the quill thru the feathers, the shaft, which bears the feathery portion.
4. Note the feathery portion is divided into two parts, a fluffy part near the quill or the *fluff*; and the flat part which clings together or the web.
5. Examine some of the web under a magnifying glass. Pick it apart to see what makes the parts cling together. Now comb it together by running between your thumb and finger. Pull out one of these little feathers or *barbs*. Note that each barb has little projections on the sides or barbules. What is the use of each?
6. Do the barbs on the fluff have barbules? Are the barbules and barbs alike or different on different parts of a feather? On different feathers? Why?
7. Draw a feather showing these facts.
   For the barring, striping, streaking, penciling, etc., of feathers, see the Am. Standard of Perfection.

EXPERIMENT 110.

Obj. Are the feathers on a fowl all alike? Describe each.

Oper.

1. Have a live fowl or better a dead one at hand. Choose as good breed as possible. Obtain a feather from the neck, back, tail, sickle, fluff, wing bow, wing primaries and secondaries, hackle, breast and leg.
2. Make an outline drawing of each. Compare them as to size, shape, color, form, etc.
3. You may cut a fowl out of a pasteboard, and sew these feathers thereon, etc.
4. Does the breed effect the feathers? How? See Standard of Perfection.

EXPERIMENT 111.

Obj. What are the feathered parts of a fowl? The other parts?

Ref.: Am. Stand. of Perf. or a Dictionary under "Fowl."

Oper.

1. Copy the drawing and parts from the text.
2. Observe a fowl in a pen with three glass sides, top and one end of muslin, bottom covered with straw, etc.
3. Sketch a fowl at hand and learn to recognize each part. Note how the feathered parts of a hen and rooster differ; cape of a hen, etc.

4. Label each feathered part on your drawing. NOTE.—Some text books give these parts; also, one chart. If not found here, see dictionary under "fowl."
5. Note other parts as head, comb with its blade and points, eye with its parts, especially the membranous lid; face, upper and lower mandible or beak, nostrils, wattles, shank with scales like a fish, toes, webs, nails, spur. Note that a fowl walks on its toes with its "foot" or shank nearly vertical and covered with scales to the heel.
6. Compare each part of our lower limbs with a fowl's; compare the upper limbs.
7. Arrange your limbs and body parts similar to a fowl.

EXPERIMENT 112.

Obj. What does this fowl score?

Ref.: Am. Standard of Perfection, Secy. Am. Poult. Asso., Cedar Rapids, Ia. ($2.)

Oper. Score the fowl. The above volume is necessary to do good work. Score card used at Waterloo and Cedar Falls Poultry Asso., Dec., 1912.

Student's Name.....
Date.....Variety .....
Owner.....Sex .....
Address.....Band No. .....
Entry No.....Weight .....
Perfect Score. Student's Score. ..

	Perfect Score		Student's Score	
	Shape	Color	Shape	Color
Symmetry				
Weight or size				
Condition				
Head and beak				
Eyes				
Count				
Wattles or ear lobes				
Neck				
Wings				
Back				
Tail				
Breast				
Body and fluff				
Legs and toes				
*Hardness of feather				
**Crest and beard				
Totals				

*Applies to game Game Bantams.
**Applies to crested breeds.
Judge.....

2. From the Standard of Perfection, fill in the points allowed for a perfect fowl of that breed; also weights, colors, etc.
3. Note the reason and amount of cuts for inspection.
4. Score the fowl at hand according to the breed it nearest represents.
5. Are there any imperfections that would bar it from entry? If so, name them.
6. Compare your score with that of another student, when finished.

EXPERIMENT 113.

TOPICS FOT POULTRY RESEARCH.

1. Structure for an ideal poultry house for 20 fowls. Ground plan, elevation, floor space and cu. ft. per fowl.
2. Poultry yards, pens, portable houses, fences, etc.
3. Nests, trap nests, roosts, scratching pens, feeding troughs, watering troughs, etc.
4. Feeding poultry; chicks, growing, fattening, laying, with rations.
5. Killing, dressing, cuts, cooking, "ripening,," etc.
6. Incubators, brooders, how to set a hen, candle the eggs fourth, seventh and fourteenth day.
7. Care of eggs, principles for breeding, storage, etc.
8. Eggs as food, kinds, relative values of each, cooking, parts of, composition.
9. Testing, sorting, grading, taste, weight, size, color, packing and preserving.
10. Five breeds of hens with their characteristics and comb-types.
11. The two best breeds: for eggs, for food, for all around purposes, with egg records ("dual purpose," "egg purpose"). Explain, "Swat the rooster."
12. Internal structure of a fowl, skeleton, systems.
13. Diseases, ailments, cures, preventatives, sanitary precautions.
14. Judging and scoring Reds.
15. Judging and scoring Barred Rocks.

The student chooses his topic, finds references in bulletins and books, inquires of persons of experience, writes a thesis and presents it to the class.